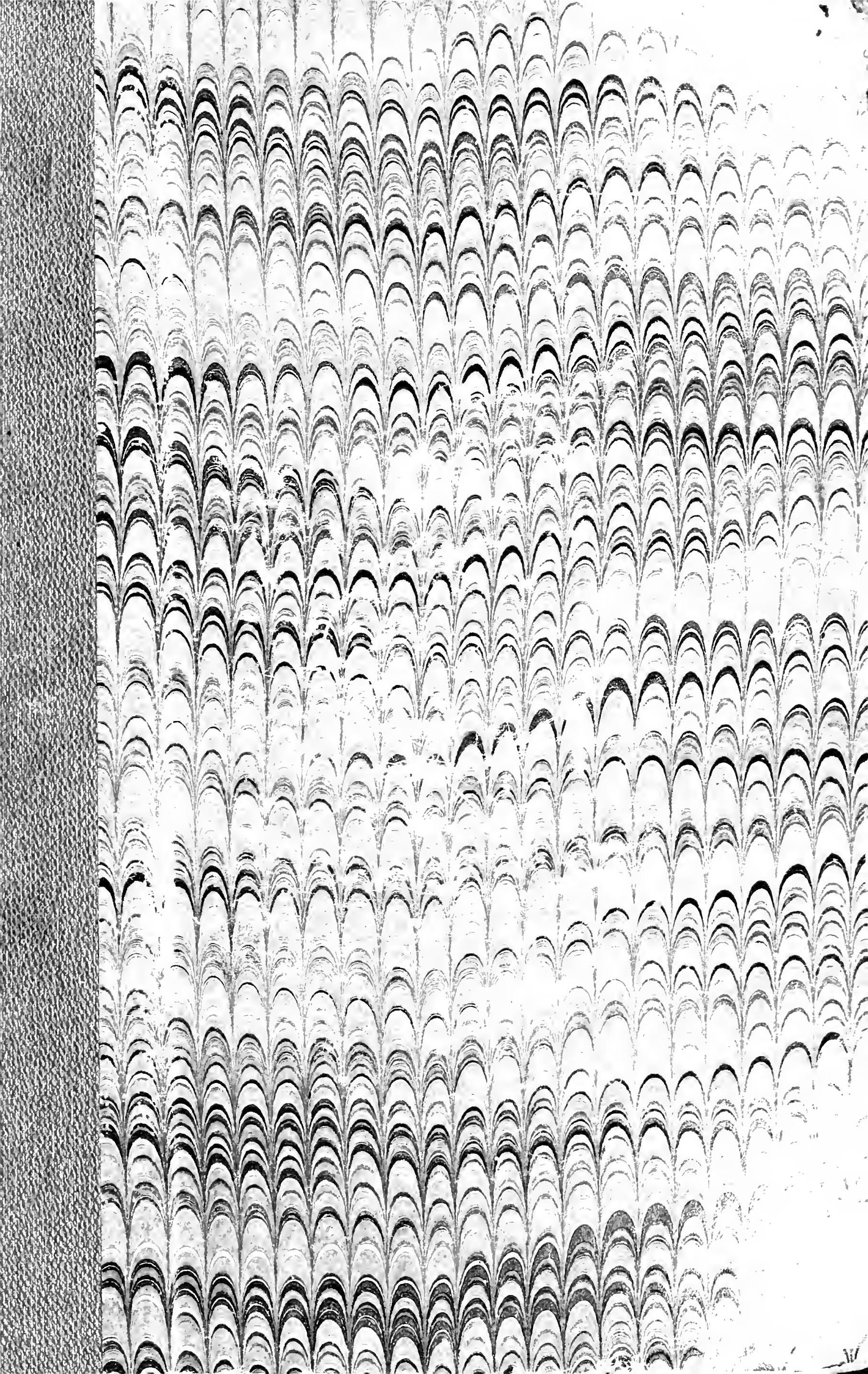

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MEMORIAL VOLUME

TO

GEORGE ENGELMANN, M.D.

Born Feb. 2, 1809; Died Feb. 4, 1884.

FOR MANY YEARS

PRESIDENT

OF THE

ACADEMY OF SCIENCE OF ST. LOUIS.

Artotype, Brimmer & Kalb, St. Louis Mo.

GEORGE ENGELMANN.

Although our Academy has met with many serious losses during its existence of nearly thirty years, it never sustained one so serious and so lamentable as that which occurred on February 4th, 1884, when George Engelmann, one of its founders, its most useful and highly respected member, its first and repeatedly re-elected President, breathed his last. His life was exceedingly active, it was spent in the service of science and kindred work, and it can be upheld fitly to the rising generation as an illustrious example.

George Engelmann was born in Germany on February 2nd, 1809, in the old and wealthy city of Frankfort-on-the-Main. Members of his family had for generations been ministers of the Gospel at Bacharach and other places along the Rhine, except his father, who, although also destined for the ministry, preferred, after his graduation at the University of Halle, the schoolroom to the pulpit, and introduced a novelty into the educational system of his time by establishing, and successfully conducting, a school for the education and training of young ladies. He was nobly supported in his laudable enterprise by his wife, the daughter of a distinguished portrait painter, G. O. May, whose family had descended from the old stock of prominent Huguenots driven from France under the reign of Louis XIV. and kindly received in all parts of Protestant Germany.

George was the eldest of thirteen children that sprang from this union, and received from his highly intellectual parents an excellent education, the effect of which was greatly enhanced by the connection of his father with the most prominent persons of the city, whose scientific attainments and enlightened conversation could not fail to make an impression upon the active and studiously inclined mind of the young scholar, and thus create intellectual inclinations which no doubt guided his sentiments and shaped his course and predilections throughout his life. He was a frequenter of the public institutions of his native city, especially the Senkenberg Institute, and, having distinguished himself as an apt and industrious scholar, he was aided in his future studies by a scholarship, which he entered upon in 1827 at the University of Heidelberg. Here he met and formed an intimate association with Louis Agassiz, Charles Schimper, and Alexander Braun, which was supported and fostered by their mutual enthusiastic devotion to the study of the natural sciences.

Having become involved in a political demonstration of the "Burschenhaft," then representing the liberal party of young Germany, he was compelled to absent himself from Heidelberg in the fall of 1828, and, after having quietly pursued his studies for the next ensuing two years at Berlin, he became induced by the great reputation of the genial Prof. Schönlein to pass the remainder of his university life at Würzberg, where he graduated in 1831 as Doctor of Medicine. His inaugural dissertation, written on this occasion, was published the following year at Frankfort, and created quite a stir among the large circle of acquaintances the young scientist had formed. It is called "*De Antholysi Prodromus*," and treats of the morphological monstrosities of plants, a subject which had been handled some forty years previously in a treatise on the metamorphosis of plants by one called "the most distinguished native of Frankfort." When this scientist received a copy of the essay through the instrumentality of a friend, he was so well pleased with its contents, and impressed so favorably with the young author who " had completely apprehended his ideas of vegetable morphology and shown such genius in their devolopment, that he offered to place in the hand of this young botanist the store of unpublished notes and sketches which he had accumulated," but death prevented Goethe from accomplishing his design.

Dr. Masters, at present the most prominent teratologist, in a recent article in "Nature," compared this treatise to the elaborate "Élémens de Tératologie Végétale" of Monquin-Tandon, and declared that, "when we compare the two works from a philosophical point of view, and consider that the one was a mere college essay, while the other was the work of a professed botanist, we must admit that Engelmann's treatise, as far as it goes, affords evidence of deeper insight into the nature and cause of the deviations from the ordinary conformations of plants than does that of Monquin." "It is a remarkable production for the time, and for a mere student with botanical predilections," remarks one of his distinguished friends; and it certainly has indicated not only the influences of his former studies and associates, but already then foreshadowed the tendency and future development of his scientific pursuits.

In Paris, where he remained the greater part of 1832 to enlarge his stock of scientific knowledge and to perfect himself in surgery and medical science in general, he met his cherished companions of Heidelberg and spent with them "a glorious life in scientific union in spite of the cholera."

The glowing descriptions which Duden had published of Western America, and dissatisfaction with the political situation of Germany, had already induced some near relatives of young Engelmann to settle in the Mississippi valley near St. Louis. Their continuous favorable reports excited their friends at home if not to actual emigration, at least to a desire of making investments in that beautiful and fertile country with a view to the future establishment of a permanent home. Young Engelmann readily accepted the offer to become the agent of the parties; he embarked at Bremen in September, 1832, for Baltimore, and went directly from there to Philadelphia, which was then known already for its advanced scientific institutions and prominent men, with whom he quickly formed a valuable and lasting acquaintance. Subsequently, after a long and tedious journey, he arrived in February, 1833, at the home of his uncle, near Belleville, Ills., which had been named Bacharach in memory of the well-known village on the Rhine, where the ancestors of the family had resided for centuries.

True to his agreements and instructions he industriously made himself acquainted with the resources of the country, the value of its farming lands, and the quality of the products on both sides of the Mississippi river, residing at his uncle's in Illinois and partly at the farm of a German in the neighborhood of St. Louis. Soon he extended his explorations farther into Southern Illinois, Missouri, Arkansas, and even into Louisiana, accompanied only by a trusted German, both a faithfnl servant and a hunter, generally known by the name of Schnatzky, who had been compelled to leave Germany on account of political difficulties.

During these exploring trips he collected a great deal of valuable information. He paid, of course, particular attention to his favorite studies, and in the new and unexplored territory he discovered a great many plants which he described, and of which he sent carefully prepared specimens for the Senkenberg Institute of his native city and for the museums of different German universities.

By such exertions he became favorably known to the scientific brotherhood of both hemispheres, and a rumor is current that one of America's most distinguished botanists found his name attached to specimens of American plants at the herbarium at Berlin, and became so interested with the excellent work which he witnessed there, that he entered upon a correspondence with the western botanist on his return to America, and a life-long friendship resulted.

However, the continuous exposure during his travels to the pernicious influence of an unaccustomed climate, and the malarial exhalations of a newly settled country with its swamps and forests, gradually produced serious results on the sturdy health of the young explorer, who became infected by one of those terrible swamp fevers, which might have resulted fatally, had he not been saved by the faithful and devoted nursing of a kind Arkansas negro family. This experience did not deter him from making another tour into the interior of Arkansas in the interest of a silver-mining company; but after that, in the fall of 1835, he concluded to settle down and commence the practice of medicine at St. Louis, which was then only a small frontier town or post of less than 10,000 inhabitants, but which had a special attraction and interest for him on account of its situation at the verge of a vast unexplored and almost unlimited territory, of whose enormous wealth he had been allowed to catch a furtive glimpse during his travels and which had excited his active imagination. He was influenced in his choice, also, by the presence of a considerable number of well-educated Germans, most of whom had left their native country because of political difficulties and annoying persecutions, and who also, in all likelihood, were driven to the outposts of civilization by a more or less adventurous spirit.

While scouring the country for knowledge he seems to have had no thought of the future and of his financial affairs; on the contrary, in order to defray the expenses of furnishing his modest office, he was compelled to dispose of his guns and pistols, and in fact of his whole travelling outfit except his favorite horse and accoutrements, at that time the most necessary requisites for a medical practice at its very beginning.

During this period he occupied his leisure hours between the prosecution of his scientific researches and his attention to public affairs. He aided in the publication of a German newspaper, the "Anzeiger des Westens," and became busily engaged in 1836 in the establishment of a German school for the benefit of a comparatively large number of German families already residing in St. Louis and its neighborhood. The results of his former investigations of the country, during his extensive travels, he elaborately set forth in articles on the climatology, natural history, and the rich resources of the Mississippi Valley, and brought them out in the "Westland," a journal to which many of his congenial companions contributed, and which was published in the interest and to attract the attention of the population of Germany to the yet uncultivated but exceedingly fertile plains of Western America. It was printed and published at Heidelberg in Germany, but was discontinued after its third number. It seems that the ability he exhibited for general affairs aided the rapid development of his professional practice. In about four years he had accumulated sufficient funds to enable him to leave his patients in the care of his trusted friend, Dr. A. Wislizenus, and to return to Germany for the purpose of marrying his affianced bride, Miss Dora Horstmann, of Kreuznach, to whom he had been engaged for ten years. On the 11th of June, 1840, he brought his young wife to his newly-established, though humble, home in St. Louis.

Engelmann's energy, love of scientific work, and constant employment of the mind, could not have failed to procure for him a prominent position in any community; but his eminent knowledge of medicine, his mild temper, his very gentle and confidence-inspiring behavior at the sickbed, and his sincere devotion to his friends, were traits of character which won him the esteem of his fellow-citizens, and, with the constant growth of a well-deserved popularity, his practice became very remunerative. This enabled him to satisfy his scientific predilections, and to pursue his favorite botanical studies. He left St. Louis a second time in the fall of 1856, in company with his wife, and devoted nearly two years to travelling and the study of botany in the Eastern States as well as in Europe, where he superintended the engraving of the plates appertaining to his great work on the "*Cactaceæ* of the Boundary," which was published by the Government in "Emory's Report of the United States and Mexican Boundary Survey."

In 1868 he repeated his European trip, accompanied by his wife and their only son, whom they left abroad to complete his studies. His numerous contributions to scientific knowledge had made his name known, and he was received with distinction by all men of science on the continent as well as in England.

During the last ten years of his life he visited and explored many different parts of his adopted country, but, whether his observations were made on the surroundings of Lake Superior and the northern country, or on the Appalachians or the Rocky Mountains — "where he saw for the first time in the state of nature plants which he had studied and described more than thirty years before" — his journeyings were invariably shared by his wife, who appeared to take as much interest as himself in his studies and observations. Their lives had become blended together, and when she, being a few years his senior, after a conjugial bliss of nearly forty years, succumbed to the overstraining of her nervous system on January 29th, 1879, it was not at all astonishing that he lost his accustomed composure and steadily refused to be consoled.

During those gloomy and cheerless days I was a frequent visitor at his home, and endeavored to divert his mind from the constant brooding over his loss, but seldom with any palpable appearance of success. One of many incidents which occurred during our many conversations was so very characteristic, and so descriptive of the mental life and the mutual understanding between this interesting couple, that I cannot refrain from mentioning it. He had often spoken to me of notes and of scientific material which had accumulated on his hands for want of time to thoroughly investigate the various subjects. I drew his attention to these points and suggested to him that the present moment was the fittest for carrying out his intentions. He entered upon the idea with unusual vivacity, and even expressed joy that he had at last discovered the means of distracting his mind. But all of a sudden he completely collapsed, and with a sad look and groan he uttered: "It will be of no use; it will remind me even more irrepressibly of my severe loss; for, whenever I had found anything new or interesting during my researches, I would show and explain it to her, and enjoy my observations doubly from the delight which she took in them. To whom shall I speak now? No; only time can heal the wound of my heart." It never was done completely; for it is asserted that, when his age had reached her years, and he then had become seriously ill, his former energy and strength failed him, and he was unable to contend, as formerly, against seemingly fatal strokes.

However, he rallied this time to some extent, and was at last persuaded to accompany Prof. C. S. Sargent and Dr. C. C. Parry on a trip to the Pacific coast in 1880. "On this memorable occasion how deeply interesting to note the fresh light of manly vigor shining out of those experienced eyes as he looked for the first time on scenes that he had so long thought over, and of gathering with his own hands the fruits of oak and pine that he had before only studied in the dried mummies of the herbarium."

"Dr. Engelmann's associates (so one of them declares) will never forget his courage and industry, his enthusiasm and zeal, his abounding good nature and consideration of everyone with whom he came in contact." All his acquaintances, and especially the large number of those who came to seek his medical advice, will cheerfully testify to his great kindness of heart and tender mercy towards all unfortunate persons. Even during the last years of his life, and with failing health, he would not refuse his professional services to those who claimed them even at late hours of the night. He often said to me, "How can I refuse to go, when they send for me?"

After his return from the Pacific coast great hopes were entertained by himself and his friends that his health had been restored and that his life would yet be spared for a number of years of usefulness; but a severe winter brought on rheumatic affections and serious disturbances which lasted until the summer of 1883, when he concluded to visit Germany once more. The voyage benefitted him greatly, and at Berlin he felt quite restored. Overestimating his strength, he engaged himself so deeply in some scientific investigations and interesting discussions with his botanical friends that he became exhausted, and, in order to regain his strength, he concluded to take a quiet rest at the home of some relatives at Kreuznach, but without the desired result. Notwithstanding, here he still continued to receive and converse with visitors, from Strassbourg and other places, on interesting questions, until alarming symptoms appeared. He did not want to die in Europe, but longed for his home in America, and the nearer he approached her shores the more improved his health became. At Cambridge he seemed to be restored; the improvement lasted until after his return to St. Louis; but, when he was again taken down during that fatal last week of January, he offered no resistance, and so ended "his honorable and well-filled life."

Engelmann's literary productions manifested a mind of close and acute observation, of critical circumspection, and a clear, conscientious judgment of the points upon which scientific determination depended. He investigated systematically, even laboriously, and never allowed any of his discoveries or new observations to appear before the public unless he himself was thoroughly satisfied with their correctness and completeness. On account of this most severe criticism exacted of himself, his first botanical work published in America became an acknowledged master-piece. "A monography of North American *Cuscutinæ*" created such a remarkable sensation among the botanists of both hemispheres as to cause its immediate republication in the two leading European botanical periodicals, the "London Journal of Botany" and "Schleidens Zeitschrift für wissenschaftliche Botanik," and an animated correspondence with the most prominent of European and American botanists likewise ensued. It was published in 1842 in the "American Journal of Science," and this introduced his name to botanists all over the country, and also to those who, residing in sparsely settled parts, were pleased to spend their leisure hours in the collection of plants, but who from lack of books of reference could not classify their collections. They, after this, forwarded specimens to him, and, after successful classification, he would publish the list in the names of the young botanists. Thus he rewarded with an introduction to the world of science, among others, C. A. Geyer, Dr. F. G. Lindtheimer of Texas, and August Fendler. The latter, as an industrious and conscientious pupil, did especial honor to his preceptor, and became distinguished as a botanist.

Being in possession of good and reliable instruments, he inaugurated as early as 1835 a system of meteorological observations, which he continued scrupulously three times daily during nearly fifty years; and such was his zeal that, even a short time before his death, he himself swept the snow from the walk leading to his instruments, and even during his last days refused assistance in making his obseivations. His journal has been kept so thoroughly and faithfully that it has become the only reliable source of information on the climatology of the Valley of the Mississippi, and his tables prepared from these observations are now authentic records. The officers of the Smithsonian Institution had early recognized his great value, and always recommended him to the scientists attached to Government exploring expeditions, who generally completed their outfits in St. Louis. His instruments, always carefully and faultlessly kept, gave an opportunity to the officers of an expedition to closely compare and regulate their own for good service on the plains and the distant mountains and valleys which they were to explore; and Engelmann also found a welcome chance to give instructions for the collection and preservation of plants and the sending of the specimens to him for determination and classification. There are very few reports of such exploring expeditions by the Government in which the part relating to botanical observations and the description of plants was not written by Engelmann. He described the first large collection of *Cactaceæ* made by Dr. A. Wislizenus during 1846 and 1847, in the valley of the Rio Grande and State of Chihuahua, while attached to the division of Col. Doniphan and during his captivity in Mexico. A report of this expedition with the description of plants, written by Dr. Engelmann, was published by the Government in 1848, and it has been stated by competent authority that this first acquaintance with this interesting family of plants "exerted a powerful influence upon his subsequent botanical studies." His descriptions of the *Cactaceæ* of the Pacific Railroad survey followed, and several years later came his most renowned work on this species of plants, "The *Cactaceæ* of the Boundary," which forms a highly interesting portion of "Emory's Report of the United States and Mexican Boundary Survey," the magnificent illustrations of which were drawn by the German artist Paul Roetter, under Engelmann's direction, and engraved in Europe as mentioned above.

Such excellent works were bound to spread his name and fame. Communications and specimens were sent in from all sides, and he treated all the different subjects with the same systematic accuracy and proficiency which had already secured his universal success. The family of the *Cactaceæ* has been treated by him in various articles too numerous to mention them separately, but, not satisfied yet with his careful researches, he intended to revise the whole order, and study the plants in their native country before he would publish the final result of his long investigations. "That he did not live long enough to elaborate the mass of material he had so industriously collected for this work is an irreparable loss to botanical science, for no other hand, in this generation at least, will be able to take up this family where he has left it." We meet everywhere in his works the same completeness and thoroughness, which has induced one of his biographers to say that "nothing of importance is yet to be added to what he modestly styles 'his notes.'" There are written by him numerous papers on other families and species of plants, the Yucca, the Agave, Juncus, Sagittaria, Nelumbium luteum, Callitriche, the Coniferæ, the American Oaks, and many others which are of great importance for the elucidation of his persevering and conscientious labor, but which cannot be enumerated here. However, his publications on the North American Vines should be particularly mentioned, for they have become very important to the grape-grower of this country as well as of Europe. The opinion of his followers as regards his literary qualifications seems to me best expressed in the language of his life-long friend, Dr. A. Wislizenus: "He was firm and decided. He did not rely upon speculations in his scientific researches, but on facts only, ascertained by severe and searching studies. He was strictly true in scientific matters."

A list of Engelmann's botanical papers has been published by Prof. C. S. Sargent, an old friend and associate, in "Coulten's Botanical Gazette" for May, 1884; this has been republished with additions, in "Der Deutsche Pionier," by H. A. Rattermann, at Cincinnati, who enumerates 112 entries, and also counts 38 scientific societies of which Dr. Engelmann was duly elected a member.

Our esteemed and munificent fellow-citizen, Mr. Henry Shaw, has caused a collection to be made of all the literary writings of Dr. Engelmann, which will be edited by Prof. Asa Gray, of Cambridge, with the assistance of Prof. William Trelease, of our own Washington University.

Having been raised and educated in a country where it is the duty and the policy of the government to protect science, and support, or at least greatly encourage its disciples, with pecuniary means, his earliest experiences during his travels in the western country had taught him that the principal care of the American government consisted in the development of the great *natural* resources of the country and all its agricultural and mineral wealth, and prepare means for its transportation, to enhance the value of the products from forest and prairie, before it could consider the providing of means for the development of science. But he also early recognized the strong influence which is exercised upon the individual effort when persons of similar purposes form an association for the encouragement of scientific research and development, and that this was the proper evolution for art and science in this country.

During the early years of his settlement at St. Louis, when the available material for such a purpose consisted of only a small number of well-educated young men, he succeeded in founding the "Western Academy of Natural Science," whose members were as zealous as could be desired; as they visited the meetings regularly, read papers and discussed them, and even collected a small library. But in such primitive communities, as St. Louis was yet in 1836, the inhabitants are usually compelled, first, to consult their material interests, under the compulsion of necessity, even if higher aims had to suffer. The young Academy never flourished; it gradually ceased to exist, and no subsequent efforts for its revival became successful until twenty years later, when the present "Academy of Science of St. Louis" was organized by the election of Dr. Geo. Engelmann as its first President, on the 10th of March, 1856. Fifteen times more was he elected to the same office, while he held that of Vice-President, also, a number of times.

At his last election in 1884, about four weeks before his death, he felt too indisposed to be present and deliver his annual address, of which he had written so many, and which were always animated with such a devoted ardor for the benefit of his beloved Academy. They were plain documents in terse language, and, like all his other writings, prepared without any desire to exalt the actual condition of things, or to exaggerate the prospects of the association. In his address of 1867 he elucidates the condition of the Academy, its past efforts for recognition among its fellow-citizens, and its actual success with the scientific communities in general, as follows:

"If we have not succeeded as well as eleven years ago some of us may have fondly hoped we should or could do; if we have not raised a palace to science and filled it with the natural productions of our own and other countries; if we have not issued volumes and volumes of scientific discoveries to enlighten the world,—we have done more than could reasonably be expected from so small a number of active men, who had only a few hours left to them by professional or business avocations to their scientific labors; and whose financial means, not aided by heavy men of our city, scarcely enabled them to hold together and preserve what they had accumulated of scientific treasures, and to publish in modest pages the results of their researches and explorations. Yes, it fills us with satisfaction and with pride to see that we have been able to gather together such a museum as we possess in the large hall, to accumulate that highly valuable library which you see in the adjoining room, and to proclaim to the scientific world through six numbers of our publications, that out here, on the banks of the Mississippi, here in this vast community of business men, some at least find inclination and leisure to prosecute the more abstract but none the less important and useful study of science."

This is a fair specimen of the praises he used to bestow upon friends — the exhortations he considered necessary to hold up to such persons as ought to have appeared and assisted materially the active workers in their scientific undertakings; and of the bright hopes he always entertained for the future existence of the Academy. However, still darker days awaited it, for in May, 1869, its hall and museum were both destroyed by fire, only the library being saved; and in his annual address of January, 1871, while reviewing the history of the Academy, he lamented as follows:

"It is that of many similar institutions. Begun with a great deal of zeal, members were numerous and full of good cheer and promise; the meetings were well attended; scientific papers were read, discussions followed, and in the succeeding year (1857) the first number of our Transactions could be published." Other numbers followed, and two fine volumes "of valuable scientific matter, the greater part of it original additions to different branches of learning" had been completed. "These publications attracted the attention of the scientific world, and brought us the most liberal exchanges from nearly all the learned societies in America and in Europe, and in fact the whole civilized world. Through these exchanges we have amassed a library of great value, which money could not buy." . . . "There are drawbacks that money could remedy. Money would build up a museum; money can, by paying competent curators, keep it in proper condition, and make it a means of instruction and ornament to the city. And money, if properly applied for, could be obtained in so rich a city as St. Louis, where a kindred institution, the Mercantile Library Association, has just celebrated its 25th anniversary with the most glowing prospects of future and increased success. But what money cannot do is to get us men of science—men who are willing to devote their labors, at least that of their leisure hours, to the building up of such an Academy as we had in view fifteen years ago, and still have in view, though the vista may be more distant."

Thus every change that occurred in the prosperity of the Academy impressed itself strongly upon his mind, and brightened up or darkened his ideas of its prospects. As he was not endowed with the remarkable gift of some peculiarly talented persons, who understand how to direct successfully the munificence of wealthy people to such institutions or problems as they are particularly interested in, he tried to use his influence upon the members to further his cherished projects, and he pleads to them in his message of January, 1880:

"Does the large, wealthy and progressive city of St. Louis contain appreciation of scientific pursuits and necessities, combined with public spirit, enough to raise such a comparatively small sum? It is believed that the first $25,000 necessary for the purchase of the property is almost ready, but that it has been subscribed conditionally only, and will not be available unless the second equal and absolutely necessary sum can be brought together." "Every day's experience shows how intimately science is connected with practical life, and how necessary one is to the other. In the New England States this has long since led to great results. Quite lately the great commercial metropolis of our Atlantic border has awakened to the same conviction, and while years ago New Yorkers almost ignored the obscure existence of their New York Lyceum, they have at present one of the best endowed and splendid institutions of Natural History, fostered both by City and State in the most liberal manner. Can not, will not the commercial metropolis of the Mississippi Valley imitate such a noble example?"

His entreaties were made in vain, and his arguments did not induce the capitalists of the city to provide for the endowment "necessary to carry on our institution, keep our library and museum in proper condition, and pay for the running expenses of curator, janitor, light and fuel." It was well known among his intimate friends that he intended to contribute himself by far the largest portion of the $25,000 that "was almost ready," but he was disappointed in his judgment of others.

His most cherished plan to see his beloved Academy located in its own fire-proof building, endowed with sufficient funds to defray its expenses and increase its library and museum, was never realized; but he had the satisfaction at last, during 1881, to find it holding its meetings at Washington University, which event he celebrated on January 5th, 1882, as follows:

"With sincere pleasure I congratulate you that on this, your 25th anniversary, you, for the first time in twelve years, meet in your own hall, surrounded by your precious library and by the germ of a museum. . . . You must at last feel that you have a home where henceforth you meet with comfort and work with the hope of success. . . . But in your new home it is expected that your meetings will attract greater public attention; you will draw around you the promoters and lovers of science in your city; the scientific zeal now awakening all over the land will also increase among us. The number of members will augment, and, with the new forces they will bring, the meeting will be more attractive, and the visible result of your work—your Transactions—will bear the name of your Academy, and of the City that fosters it, to all parts of the civilized world."

Thus have I endeavored to depict by his own penciling the great interest and devotion which Dr. George Engelmann invariably exhibited for the Academy, and the very commendable zeal which he constantly evinced and practically demonstrated for its progress and ultimate success. If during his life-time this success was not as brilliant as he desired and expected it to be, it was simply because this incomplete success occurred in spite of his constant efforts; for it must be acknowledged that from its foundation he was identified with the Academy to such an extent that a review of the last third of his life may be justly called a review of the history of the Academy. All his essays and papers, with very few exceptions (perhaps those which were published by the Government), and all his observations and notes on various subjects, were reserved for the Transactions of the Academy, and in this respect he has done more than any other member for the establishment of its fame and reputation among the scientific world.

This remark should not be misunderstood. The writer has not the slightest intention of robbing well-deserved laurels from the crowned brows of our distinguished members, rightfully praised by Engelmann himself for their indomitable and energetic support of our institution. It only expresses his own opinion, and reiterates the sentiments of the members of the Academy who have publicly proclaimed it time and again by placing Dr. Engelmann almost continuously (sixteen times in twenty-eight years), and very often against his wishes, upon that post of honor, the duties of which he graced with such wonderfully modest and amiable urbanity,—effectually leading the discussions, giving desired and timely information on every subject when necessary, and being ever ready to entertain the members present at a meeting with the inexhaustible mine of his scientific lore, when no papers were offered or the discussion on the topics presented had been exhausted.

There is no possible doubt that those who have been associated with him, and admired his mild manners, his gentle but decisive method of giving his opinion, will ever cherish his memory; and members who have not enjoyed the delight of his personal acquaintance will learn from the "Transactions" of the Society, and from the older members, the esteem and gratitude that all owe to the memory of our lamented President, Dr. George Engelmann.

ENNO SANDER.

CONTENTS.

LIST OF OFFICERS AND MEMBERS FOR THE YEAR 1886.

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Chouteau, C. P.
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Cook, Isaac
Curtman, C. O., M.D.

Dixon, B. V. B.

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TRANSACTIONS.

The Geological and Geographical Distribution of the Human Race.

By Nathaniel Holmes.

Until quite recently the consideration of the Human Family has been for the most part restricted to existing races as they were found distributed over the surface of the earth within the historical period. Modern discoveries in archæology and geology have given rise to what is called Prehistoric Man. The strict methods of science, admitting nothing but the dry, discrete facts of actual observation, and jealously eschewing everything that savors of speculation, tends to produce narrow views even of the Prehistoric period. There is no reason why anthropology should not invoke the aid of all other sciences. If one kind of scientific proof be unattainable, other kinds of evidence, surely, may be resorted to. Especially, the whole science of zoölogy may properly be brought into requisition. And if this were not enough, it is not easy to see why metaphysical science should not come to our aid as well; for the nature of man is both physical and metaphysical.

The recent work of Mr. Wallace,* in a manner supplementing the instructive labors of Mr. Darwin, may help to enlarge the scientific horizon on this subject. The distribution of the human races, geologically, or geographically, did not come within the scope of his special purpose; but his important demonstrations with regard to all classes of animals below man may certainly be taken as affording solid grounds for more definite and reliable conclusions in reference to the human race as well. Looking far back into the Tertiary period, Mr. Wallace divides the land areas

* The Geographical Distribution of Animals. By Alfred Russell Wallace. London, 1876.

of the globe into six zoölogical provinces in reference to the geographical distribution of animals, briefly, thus:

I. The Palæarctic, comprising Europe, Asia north of the Himalayas, Western Asia, and Africa north of the Great Sahara.

II. The Oriental, comprising Hindostan, Indo-China, the Malayan peninsula, and the islands from Sumatra to Celebes inclusive.

III. The Australian, comprising Australia, New Guinea, New Zealand, and the more eastern Pacific islands as far north as the Sandwich Islands inclusive.

IV. The African, comprising Africa (south of the Sahara) and Madagascar.

V. The Nearctic, comprising North America and a part of Mexico.

VI. The Neotropical, comprising South America, Central America, Southern Mexico, and the West India Islands.

This division is founded upon geological evidences as well as upon a minute survey of the distribution of all classes of animals (except Man) as now living, with some considerate glances at the fossil forms as far back as the Eocene. His results furnish additional proof to justify the conclusion which other writers, as well geologists and botanists as ethnologists, have drawn from known facts, that the Asiatic continent extended southeastwardly in Mesozoic times so as to include Australia and New Zealand; but he infers that, during the Tertiary, New Zealand was separated from Australia, and at length Australia from the mainland, by the gradual sinking of the continent; and, finally, he comprises all the islands lying to the southward and eastward of Celebes, including the Sandwich Islands, together with Australia and New Zealand, in one distinct province called the Australian. He infers that, within the Tertiary period, South Africa was separated from Northern Africa by an ocean covering the Sahara, and that Madagascar was connected with the mainland; and that, within the same period, South America was separated from North America by an ocean over the isthmus, as indicated by a comparison of the fossil and living animals on either side. Brazil and Guiana were also separated into islands by an extension of the ocean between them and the Andes. In like manner (as he might have added) the eastern portion of North America was effectually separated from the western portion, first, by a mediterranean ocean, which was cut off by an elevation of the continent in that part at the close of the Cretaceous period, and secondly, at the close of the Eocene period, by an immense fresh-water lake, covering the region of the great plains to the east of the Rocky Mountains, and extending northwardly from middle Kansas far into British Columbia; and this lake was still further enlarged, at the close of the Miocene, so as to extend southwardly over the region of Texas and the Gulf of Mexico, making an effective water barrier to the end of the Pliocene period.*

Many considerations justify the inference of Mr. Wallace that, at times within the Miocene and Pliocene periods, there was a further extension southwardly than now exists of the continental shores of Asia so as to give a continuous land area from Celebes around to South Africa, including what is now Java, Sumatra, Ceylon, Hindostan, the islands to the northward of the Seychelles, and Madagascar, mostly within the tropical zone; and also, that a like seaward extension of the eastern shores of Asia, in consequence of greater emergence of the land in those times, reached around by Japan and the Aleutian Islands inclusive to the North American coast, while warm temperatures still continued in those latitudes.

These views are further supported by the recent soundings of ocean depths over the globe, by which it appears that an elevation of less than 100 fathoms (30 fathoms, according to Dana and Marsh), in the region of Behring's Straits, would join the two continents by a wide belt of land. And an elevation of 500 to 1,000 fathoms would give continuous land from Scotland by the Faroes and Iceland to Greenland, and even to Canada and New England. Eminent botanists, on a comparative study of the plants of Europe and America, and of Spitzbergen and Greenland, have been led to infer, that there must have been some such land connection in Tertiary times, by means of which plants native to America found their way into Europe, or were distributed into both America and Europe from the Arctic region. The Miocene flora of Spitzbergen as described by Heer (according to Prof. Gray) has "two Magnolias, representing, probably, the highest degree of temperature of the Arctic of that epoch, equivalent to

* Systematic Geology. By Clarence King, U. S. Geologist. 4to, pp. 450-458. Washington, 1878.

that of the present time of the middle States of North America," where Magnolias still survive. It seems highly probable, even if there be as yet no certain evidence of the fact, that there continued to be land above water in that North Atlantic region until times within the human period. Some geologists have deemed it quite probable, and Mr. Croll* has given some proofs, that Greenland was connected with Northern Europe as recently as the glacial epoch. The stone implements discovered by Dr. C. C. Abbot in the river gravels of the Delaware (according to Prof Shaler) "prove the existence of interglacial man on this part of our shore."

But geology demonstrates that the continents have been distinctly marked out and separated in the main (though not entirely) by deep and wide seas from the earliest periods. The recent soundings render it probable, if not certain, that there has always been a deep sea between Madagascar and Australia in the direct line across. This would seem to preclude the conjecture of some writers (and more recently of Haeckel† and Peschel‡) in the manner as stated by them, that a continental "Lemuria" once existed there, which is now sunk beneath the Indian Ocean. There is perhaps no longer any need of so large an assumption, since the land extensions, suggested by Mr. Wallace, appear to be sufficient to explain all the known facts, and are far more certain in a geological point of view.

Upon this general survey, taking into view the configurations of continents and oceans and the continuity of land areas, in the Miocene and later times, in reference to the geological and geographical distribution of the Mammalia, the first great facts that strike the mind are these: That, as far back as the Eocene, Lemurs existed within the Palæarctic province above defined, and extended southwardly into Madagascar on the west and into Celebes on the east, where they still survive in some species, having been sufficiently protected from entire extinction in those remote situations; that in the Miocene the Simiadæ also existed within that same Palæarctic area, where they for the most part have become extinct (as the Lemurs also have entirely), in later

* Climate and Time in Geological Relations. By James Croll. New York, 1875.

† History of Creation. Trans. by E. Ray Lancaster. New York 1876.

‡ The Races of Man and their Geographical Distribution. By Oscar Peschel. New York, 1876.

periods, though they still survive in some species in the forest-covered regions of the South African province and in the ORIENTAL area, of which Sumatra and Borneo may be taken as a centre, in which now separated provinces they have had a distinct evolution into the differences of genera and species that still remain; that the same appears to be true of the larger Carnivora and the Elephants, which once extended farther north in the Palæarctic province, but became extinct, in later periods, within that area, though they still survive in the species of Africa and India; and, finally, that in the Upper Miocene, the anthropoid Apes (*Dryopithecus* and *Pliopithecus*) lived as far north in the Palæarctic province as Greece and France, in which province they have long since become extinct, though they still survive in the Orang of the ORIENTAL area and in the Chimpanzee and Gorilla of South Africa, in zones of tropical forest.

Now, in regard to Man, it is manifest that his distribution over the earth must have pursued an analogous course, under the threefold operation of evolution, migration over continuous land areas, and extinction in some areas; and that all existing races are like survivals in branching lines of descent, reaching back to the earliest progenitors that might be called human, within the Tertiary period, and that those earliest progenitors may have dwelt as far north as the Palæarctic province.

It may now be considered as scientifically demonstrated that Man existed in Europe in the Miocene period. It was long since satisfactorily proved that he existed there during the interglacial warm epochs, if not in preglacial times; and it was a rational inference that he must have lived there in the Pliocene. While discoveries of human remains were as yet limited to the Quaternary period, this whole time was considered under two divisions: one called the PALÆOLITHIC epoch, from which stone or flint implements were the only remains, and the other called the NEOLITHIC, from which human skulls and bones have been preserved, together with implements of horn, bone, and ivory, as well as stone or flint. The antiquity of these remains can be expressed only in terms of geological time; but the facts show that the whole of historical time would be as nothing to the length of the Neolithic epoch, and that this Palæolithic epoch must have been immeasurably longer still. These Neolithic skulls differ much in type, some of them being of extremely low forms, while others are not remarkably inferior to the older skulls of known white peoples, and they are thought by some to resemble those of the Lapps, and by others to be not much unlike those of people who still survive in France. The inferior type is said to indicate a race small in stature, with a small brain, retreating forehead, prominent superciliary ridges, and projecting jaws.

More recently, Dr. Paul Broca has established the existence in Europe of at least three distinct fossil human races, connected with two essentially different types: one the dolichocephalic (long-headed), the other the brachycephalic (short-headed). The three races are distinguished as those of Canstadt, of Cro-magnon, and of Furfooz. The first is described as long-flat-headed, of which the Neanderthal skull is an example, recalling the form of the head in the anthropoid Apes. The cranial capacity is even smaller than that of the Hottentots and Australians. Other characteristics of inferiority are the prominence of the incisors, the great size of the jaws, the total absence of chin, and of the alveolar arch. This race appears to have been nearly exterminated by the intrusion of that of Cromagnon. This intruding type approaches that of the Caucasians, but exhibits peculiarities which distinguish them from all modern races. It coincides in age with the second or Neolithic half of the Quaternary epoch. The race of Furfooz, which goes back to the age of the Reindeer in France, was a small, brachycephalic or round-headed type, being only from 4½ to 5 feet in height, "descending to the level of the Lapps." It approaches nearer to the race of Canstadt than to that of Cromagnon. They dwelt in caverns and lived by the chase. Their implements were of a rude sort, but they made pottery. This is said to indicate a date a little before the epoch of polished stone. These Neolithic people were all evidently savage barbarians, living as hunters, sheltered in caves, and were eaters of raw flesh. The Palæolithic men must have been in a still ruder and merely animal condition. Both have been spoken of as having a mode of life resembling that of the Esquimaux, or the Australians. Not that they were necessarily the same in race, but only (for that matter) that they belonged to branching streams of the human family that had as yet only reached a stage of progress comparable with that in which these races now are.

Prof. Dawkins supposes that these skulls of the higher type may have belonged to the ancestors of the Celts; but the more recent discussions of the French anthropologists, indicating the existence of several distinct types rather than any one that might be called Celtic, would seem to negative such an inference. In some from the valley of the Vézére, Dr. Broca finds certain peculiarities in the anatomical structure, in respect of which they approach nearer to the gorilla than to modern men, while in other points they differ more from the apes than do the present races. M. Topinard* concludes that the dolichocephalic and platycephalic type of the skulls of Canstadt, Eguisheim, &c., and of the Neanderthal skull, was that of the oldest people whose bones have yet been found in France; that at the close of the Palæolithic epoch a brachycephalic people appeared in France in small numbers, and were followed by an invasion of dolichocephals from the north, and that there was then another invasion of brachycephals, at the close of the polished-stone epoch, along both sides of the Alpine range, and that these people, mixing with the original races, formed the Celtic type in central France. But, considering that the remotest historical researches concerning the Celts do not trace them back beyond the 16th century B.C., and then exhibit them in a course of migration from the east, and that these men of the Neolithic age must have been older by incalculable centuries, any identification of them with the historical Celts becomes entirely imaginary, and must be deemed quite inadmissible.

Prof. Dawkins and some of the French ethnologists agree in identifying the smaller race as the ancestors of the short, black-haired, brown or swarthy people called Iberians or Basques; and this brown race is traced from the shores of the Mediterranean Sea to the British Islands; and they are considered to have been the cousins, if not the direct descendants, of the brown race of Northern Africa. That a brown race once occupied both shores of the Mediterranean Sea, and were the ancestors of the Basques, may be highly probable on many grounds: but the identity of this race with the small people of the Neolithic epoch may very well be doubted until better evidence than any yet found has been produced.

* Anthropology. Trans. by R. T. H. Bartley, M.D. London, 1878.

Again, Prof. Dawkins conjectures that the older Palæolithic men may have been the ancestors of the Arctic Esquimaux; but the only ground stated for this inference is, that they appear to have lived under like conditions, and used similar implements and arts. This assumption would imply that these people had retired out of Europe, either northeastwardly across all Siberia to North America, or northwestwardly over land now submerged to Greenland: or that they had become wholly extinct in the European area after the glacial epoch; or, again, that, prior to that epoch, they had migrated westwardly from America across all Asia into Europe, and afterwards become extinct in the European area. Either supposition is perhaps possible. The Tchutchies, Samoieds, and other tribes of Northeastern Siberia are described as more nearly resembling the American Esquimaux than the Mongols of Asia: and it is very probable that they crossed Behring's Straits from America in recent times. Such migrations may have followed the Arctic shores even into Europe in very remote epochs. Indeed, during the warm temperatures preceding the glacial epoch, there would seem to have been nothing to prevent their distribution all around the Arctic circle. And considering the vast lapse of time and the wide extent of such possible migrations of the more primitive peoples, together with the effect of extinctions over large areas in later times by the pressure of more warlike and superior races upon them, and that possibly within the glacial epoch there may have been a land connection between Northern Europe and Greenland, the hypothesis may not be unreasonable. On the other hand, the proofs seem to be quite as strong that Europe was first inhabited by races entering it from the southeast.

Here, it must be borne in mind that this division of the Quaternary into two or more epochs is in some measure arbitrary, however convenient for study. But there is no need of supposing any break in the continuity of animal life through all actual changes. There were alternate elevations and submergences during the glacial epoch, at times uniting the British Islands with the continent, and joining Europe with Northern Africa across the Straits of Gibraltar, and across by Sicily and Malta to the region of Tunis: and, in the alternations of climate, animals of the southern or African fauna and arctic animals, as well as those of more temperate regions between them, were ranging northward or southward as the conditions changed. It is certain that some Pliocene species of mammalia were continued into the Postpliocene of Europe without much change, while others were greatly modified. That these Palæolithic men were in a stage of progress in arts and modes of life and mental capacity, not above the rudest stage of stone implements, is certainly an important fact; but it has no tendency to prove an identity with the Esquimaux in respect of race. Later, and in the Neolithic age, we have peoples that had learned the use of bone and ivory, of barbed spears for catching fish, and of bone needles for sewing the skins of beasts, and had acquired some skill in etching or scratching figures of animals on pieces of ivory, horn, or bone. Evans* finds in the Palæolithic caves and river gravels in England three stages of human workmanship, distinguishing an age of roughly-chipped, another of finely-chipped, and a third of polished flints, corresponding to similar divisions of the French anthropologists. Geikie† separated the glacial epoch into an alternation of glacial cold and interglacial warm ages, and demonstrated that the Palæolithic men of the rough flints were as old in Northern Europe as the first interglacial warm age, and in all probability as old as the preglacial mammals of southern types, (hippopotamus, rhinoceros, &c.), with which their migrations were associated. This association would rather indicate a southeastern origin. Evans admitted that human remains might yet be found in the Pliocene or even in the Miocene. Dawkins‡ concludes that the extinct mammalia with which man was associated in Europe were preglacial, and that man in all probability migrated into Europe with them in preglacial, that is, in Pliocene times. We have the authority of Prof. Whitney for the existence of human remains in the Pliocene of California, and of M. Desnoyers for their existence in the Pliocene chalk-pits of St. Près in France. Prof. G. Capellini of Bologna has described bones of a cetacean (*balænotus*) from the Pliocene of Tuscany, showing deep cuts with a sharp instrument, which he believes to have been the work of man, before the bones became petrified. Sharp-

* Ancient Stone Implements, &c. By John Evans. London, 1872.

† Great Ice Age. By James Geikie. F.R.S. London, 1874

‡ Cave Hunting. London.

ened stakes have been reported from the Pliocene deposits of Switzerland, but the work was so rudely done that it was considered doubtful by some whether it were the work of man or the beaver. In 1872, M. Bourgeois, produced worked flints from the Miocene marls of Thénay in France, which were then thought by some archæologists to be mere sports of nature, so rude was the workmanship. But in 1873 more perfect specimens of well-chipped spear-heads from the same marls, produced before the Anthropological Society of France, were pronounced by M. Mortillet to be unquestionably of human workmanship: and he claimed the right to speak of "Tertiary man, or (more exactly) the precursors of man." Dr. Paul Broca recognizes these facts as collected by competent observers, as accepted by many eminent *savans*, and as showing "the existence of an intelligent being who knew how to cut flint, and who could be nothing else than man," in the Middle Miocene; but he conceives that they are "not yet sufficiently numerous nor incontestable to constitute definitive proof" and to place Tertiary man "on the platform of science."

Thus we find traces of human workmanship so rude and indistinct that it is difficult to determine whether it was the work of art or nature. It has been objected that no one species of mammal of Miocene age had come down unchanged to the present time, and that these Miocene evidences of human agency were so immensely anterior to the Quaternary men of the flint implements as scarcely to be credible or admissible. But it has been answered, and very justly, that by the light of zoölogical science it is not at all necessary to suppose that these Miocene men were even of the same species as those of the Quaternary epoch; unless, indeed, the idea of a species must include types as low in the scale as the Gorilla. There must certainly have been a time when the earliest creatures which we would venture to call human were just beginning to learn how to chip flints and sharpen stakes. The African gorilla knows how to build a platform for his bed on the branches of a tree, and it is said he will come down and warm himself by the fire which the hunter has left; but he does not know enough to put on more wood to keep the fire burning. His reason does not see the logical connection between the fire and the wood, and his eye has never discovered the sequence of fact.

In a general view, it is manifest that for the origin of the human family we must go back nearly (if not quite) to the beginning of the Miocene period. M. Topinard places the marls and spear-heads of Thénay in the Lower Miocene: and he considers the existence of Man in this stage of the Miocene formations to be a "clearly revealed scientific fact." The condition of things in the Eocene, or Cretaceous, period was not such as to render it probable that any form or type of creature that could be called human then existed. But in the Miocene the geographical configurations of land and sea, the character of the fauna and flora and other physical conditions, and the large developement of the Ape family into species (some of which in size exceeded the human stature), may render it highly probable (if not quite certain) that the complete transition to the human form had then taken place. The Miocene *Dryopithecus* is found to exhibit, not only anthropoid characters, but a dentition intermediate between that of man and the apes. It is somewhere in this period that Dr. Darwin* has placed his synthetic type of the earliest progenitors, partly human and partly ape-like in form, from whom have descended in branching lineal descent the human streams, running parallel with other contemporaneous lines of descent which have deviated in other directions, or which have, in later times, either become wholly extinct, or only reached as yet such forms as those of the Orang and Gorilla. And, in a purely zoölogical point of view, he finds no reason to doubt that the very first deviations, leading to the Catarhine Apes in one direction and to human forms in another, began as far back as the Eocene. It is very certain that, in the course of these vast periods of geological time, innumerable tribes, peoples, and varieties or races, have become extinct. Some peoples are known to have become extinct within the historical period, and others are fast disappearing. Indeed, these Palæolithic men of the flint implements must be regarded as an extinct people, if not an extinct race. The ancient Mound-builders of the Mississippi valley and the stone-builders of Central America may be said to be extinct, though they were doubtless branches of the whole American stem, which still survives in the existing peoples of the red race.

That man existed on the western coasts of North America, in

* The Descent of Man. New York, 1871.

the Pliocene, can scarcely be doubted since the discoveries in California reported by Prof. Whitney. Nor can it now admit of question that men lived on the shores of the Delaware and on the eastern coasts as far back as the glacial period, to which the stone implements discovered by Dr. Abbot in the gravels of that river have been assigned. It is equally certain that men lived with the mastodon in the times of the Loess of the Missouri valley, as proved by the recent discovery by Dr. Aughey, in Iowa and Nebraska, of mastodon bones and flint arrow-heads lying togethei in that deposit under such circumstances as to exclude the possibility of later driftings; not to mention similar discoveries of the late Dr. Koch in alluvial river bottoms in Missouri, where such driftings were possible. Human remains have been found, also, in Postpliocene caves in Brazil and Buenos Ayres. But hitherto none have been discovered in Miocene deposits on this continent. To the eastward of that great Pliocene lake that extended along the Rocky Mountain range from where the gulf of Mexico now is far northward into British America, neither human nor elephant remains have been found in Pliocene or any earlier deposits. It was not until the end of the Pliocene that this ancient barrier was cut off by the further elevation of the continent; and then only is it probable that either man, or the mastodon, or the megalonyx and other South American types of animals, could cross to the eastern portion of North America; and it is in Postpliocene deposits only that their remains are found in that area, No anthropoid apes have ever been found anywhere on the continent of America. Thus, while it is certain that man existed in the Miocene period on the other continent, the earliest evidences of his existence on this continent belong to the Pliocene of the Pacific coasts; and this fact points to the Pliocene land connection across Behring's Straits as the pathway by which he reached America.

The question now is, in what part of the earth the human type first appeared. Hitherto, geologists have pointed to Southeastern Asia as the most probable place of origin; and some writers have imagined a sunken *Lemuria* in the Indian Ocean. Prof. Owen has significantly intimated that the Australian negroes are a survival of one of the oldest races of the earth in those remote islands where they have found protection from the aggressions of later and stronger races; and that they still exhibit a certain quadrumanous proclivity to nakedness and a savage repugnance to anything like civilization. The same thing may be said of the Buschmen of Southern Africa. Like survivals of older types appear elsewhere in the midst of races with which they have little or no affinity of type, or language; such are the Ainos, the Mincopies, the Veddahs, and the Basques. The geographical position of the Negro type in the Australian province on the one hand and in the South African on the other, now so far separated, is obviously analogous to that of the Lemurs in Celebes and in Madagascar (a type which goes back to the Eocene in Europe); and it is quite analogous to the distribution of the anthropoid apes into South Africa on the one hand and into the ORIENTAL province on the other (a type which goes back to the Miocene within the *Palæarctic* area). And it is obvious that if human forms existed within that same area in the Miocene, their range may as well have extended from Asia to Europe, as did that of the higher apes. In such case, there could be no more difficulty in accounting for their distribution southwardly into South Africa on the one hand and into Australia on the other by the pathway of continuous land, then extending around from Australia to Madagascar and South Africa, than in the case of the lemurs and the anthropoid apes. It is certain that until the glacial epoch there was no such cold in the European portion of the Palæarctic province as would drive such primitive men more southward on pain of extinction in that area. Other causes indeed may have destroyed them in those more northern areas, where the anthropoid apes certainly perished, before the glacial times. The extinction there of the inferior tribes and types may have been caused by the aggressions of the stronger races that had arisen in the course of time. That this Negro type did once extend from Australia around to South Africa, there is some confirmation in the fact that even now as we go northward from Australia this type may be distinctly traced as still surviving, in some part only as a modification of form and color as in the Negritos, the Mincopies of the Anduman Islands and Borneo, the Veddahs of Ceylon, and the black tribes of the Nilgherries in Hindostan, but for the most part as mixtures of the Negroes with other races, forming the various negroid peoples that still survive in those areas and along the coasts of Hindostan and Beloochistan even to the ancient Colchis on the Black Sea, where traces of them were found within the historical period. At the earliest Egyptian dates, Negroes were known to the Egyptians as living to the southward of Egypt. On the monuments of the XII. Dynasty, 2300 B.C. (according to M. Topinard*), prognathous negroes with woolly hair, called *Nashu*, are figured, together with red, yellow, and white races. On all historical data, it would appear that the aboriginal area of the African Negroes must have been to the southward of the Great Sahara as well after as before the ocean retired from it; that is, they properly belong, in all recent times, to the South African province of Wallace. But all idea of an absolute and entire separation of this province from the Australian, in all earlier periods, may as well be abandoned.

In a general view, and leaving out of consideration the intermediate gradations due to migrations and intermixtures at later dates, the Negro type is found occupying, on the whole and as well in geological time as in the historical period, the southernmost areas of all the human populations. The brown and reddish-brown types occupy, on the whole, the next more northern areas, extending in the western direction by Hindostan across the Indus to Southern Arabia and Northern Africa and Southern Europe even to the Azores, first peopled by the Guanches, and in the eastern direction over the ORIENTAL province and the Pacific islands, with more or less of mixture with other types, even to New Zealand and the Sandwich Islands. It is evident that the yellowish types originally occupied areas lying still further northward and more inland, though the Malays and Indo-Chinese and some offshoots from the more northern Caucasian or white stock have, in later times, ranged southwardly over the same islands of the Pacific, overlaying or driving back the older brown and black races and largely mixing with them. This was the conclusion of Col. Hamilton Smith many years ago, as it is also that of more recent ethnologists, and it is sustained by many evidences. The Kawi languages of these brown and yellow races, extending from the Malayan peninsula to Madagascar and over the Pacific islands to the eastward, afford some confirmation of this general course of distribution. The recent studies of Mr. Whitmee of Australia

* Anthropology, tr. by Bartley, p. 428.

upon the Polynesians bring him to a similar result. Such also appears to be the opinion of M. Hamy. There are indeed different shades of color among the negroes as well as among the brown or the yellow races. Nevertheless, when the probable course of migration and geographical distribution is duly considered, the general distinction of black, brown and yellow bands of color becomes as apparent as is the distinction of the white band of color and type of the still more northern Caucasian race from all the rest. This distinction of bands of color and type is strongly confirmed by the observations of Dr. E. Lambert of the Royal Academy of Belgium upon the differences in the structure and size of the teeth in these several divisions of race; and, in this respect, the ascending scale of evolution in the order of black, brown, yellow, and white, is distinctly manifest. Such anomalous peoples as the Esquimaux, the Australian negroes, the Hottentots, and the Fuegeans, are to be regarded as survivals of the older races, which have been crowded into the outer extremes in very remote epochs; and so, in reference to these several bands of color, their existence in these opposite localities is rather confirmatory than exceptional.

The three distinct species of the human family defined by M. Topinard* admit of arrangement in a corresponding order, thus:

I. BLACK. More dolichocephalic, black skin, hair flat and rolled to a spiral, very prognathous, radius long, buttocks prominent, breasts (in female) elongated.

II. YELLOW. Brachycephalic, low stature, yellowish skin, broad-flat base, oblique eyes with contracted eyelids, hair scanty, coarse and (in section) round.

III. WHITE. Dolichocephalic, tall stature. fair complexion, narrow face projecting on the median line, hair abundant, soft, light color, and (in section) elliptical.

M. Topinard does not undertake to make a distinct species of the brown and reddish-brown races. He regards the Berber type as composed of a brown autochthonous ground-work and a mixture with northern blonde whites, eastern Arabs, and southern negroes. The Berber type may have been composed in that way; but the brown autocthonous ground-work is not thus accounted for. It is perhaps possible that a brown type may have been

* Anthropology, by Bartley, p. 511.

formed, at a primitive date, by the mixture of black and yellow types; but there would seem to be no good reason for doubting that the brown color was contemporaneous with the earliest evolution of human types; and the immense area occupied by the brown races, between the yellow and white types on one side and the black type on the other, would seem to furnish strong evidence that such must have been the truth.

Those ethnologists who have taken a minute survey of the human family, as it is now distributed over the earth, have found it difficult to define the number of distinct races. On such superficial survey, the number has grown from five or seven to twenty, sixty, or more than a hundred. The strictly ethnographical review of Dr. Latham, like that of Dr. Pritchard, taking the races and peoples as they now are, and without much regard to their geological history in time, or to the question of race in the sense of natural lineage, finds them gradually merging into each other in form, color, capacity, language, and customs. Dr. Pickering experienced a like embarrassment in distinguishing as many as eleven races. But it has now become necessary to consider the human races as we do animals and plants in reference to lines of descent and travel over different surfaces in times stretching backward into the geological periods. In this deeper view, and with due regard to geographical distribution, the several distinct bands of color and type above specified become perceptible, though at the present time they appear to shade off by almost insensible degrees into each other, like the bands of color in the solar spectrum.

It is much the same in respect of stature. These distinct bands of color and type, compared as wholes, show an average difference of stature and size of brain, while the gradations are considerable within each band. The best authorities find that the mean internal capacity of the skull in the white race is 92.3 cubic inches; in the American reddish-brown race, 87.5; in the Asiatic yellow race, 87.1; and in the black race, 81.9. In stature, the Australian Negroes, the Negritos, the Mincopies and Veddahs of the east, and the Buschmen, Hottentots, Akkas, Obongos and other tribes of Africa, are by whole peoples only about 4½ feet in height; the yellow Asiatics are in general short and slender, many tribes being only 5 to 5½ feet in height; the brown and reddish-brown peoples are in general shorter and slimmer than the white race, many tribes being only 5 to 5½ feet in height, while some tribes, or individuals, have been described as tall and stalwart men; but, on the whole, the largest and tallest peoples are found among the white race. At the same time, considerable differences in individuals exist in either division. The same appears to be true in a greater degree of the different species of apes and lower animals; and it may be safely inferred that like differences within the same tribe or the same race, and between distinct races, have always existed, even backward to the earliest progenitors of either.

Some of the American Indians partake more or less strongly of the Mongoloid type that prevails among all the peoples of Eastern Asia from Malacca to the Arctic Ocean. This might be expected in northwest America, where the contact with northern Asia has been nearer in all recent times. The more ancient and more civilized peoples of Mexico and Central and South America depart farthest from the Mongolian type. On a general comparison of Mongolian and American skulls, and especially those of greatest antiquity, a well-marked distinction is manifest, and particularly in the brachycephalic division of them, as may be seen in Morton's "Crania Americana." Morton found the difference sufficient to distinguish the American from every other race. Peschel includes the yellowish Malays among the Mongols. This yellowish color grows lighter as we go northward and inland, and ascend the Himalayas and the higher plateaus of northern Asia. The Chinese are lighter than the Malays; the Japanese of the islands are darker than the Chinese; and the Americans generally are still darker. The Malays, Indo-Chinese, Chinese, Japanese, and the Mongolians of higher Asia, and in like manner the American Indians, may be considered as having occupied their several distinct areas from times reaching far back into the geological periods. Agassiz noted the fact that the areas now occupied by the different races of men corresponded with the several zoölogical provinces, characterized by different species of animals; and this must imply an occupation of those distinct areas for a sufficient length of time to account for differences analogous to a difference of species. This difference of habitat and climate, operating through an immense period, may help to account for the actual differences of type and color between them and the red Indians; while such Mongoloid resemblances as really exist may be explained, in part, by an affinity that must have originated from some mixture as far back as the Pliocene period, when the reddish-brown race was making its passage along the eastern coasts and islands of Asia (since submerged) into northern America, and in some part by more recent infusions and mixtures by way of Behring's Straits, or across the Pacific. But however much the Americans resemble the Mongolians, their resemblance to the Guanches, Berbers, and other ancient peoples of the western branch of the brown band of races, is quite as near, and their resemblance to the brown race of the Pacific islands (the eastern branch) is still greater. Due allowance must be made for long separation into distinct areas.

The general truth is undeniable, that the colors of the existing peoples of eastern Asia become lighter as we ascend the Himalayas from southern and eastern India, and enter upon the elevated and colder regions of northern Asia. This view is countenanced by what has happened to the historical Aryans in Hindostan, in a reverse way. They are known to have descended into the plains of India from the elevated regions to the north of the Hindu Kush, most probably (according to Bunsen) twenty thousand years ago at least, subduing and overlaying the brown aboriginal natives of lower types. They have retained for the most part the stature and features and intellectual superiority of the Caucasian race, but in color they have changed to various shades of brown, according to the country they have inhabited. As we now find them, they are darker as we descend toward the Gangetic plain. The Dârds, occupying the valleys of the upper Indus, at an elevation of eight to ten thousand feet above the sea, and in latitude 34° to 36° N., are of a complexion (says Mr. Drew*) "moderately fair and sometimes light enough for the red to show through it"; and they are stout, well-proportioned, of a good cast of countenance, with hair usually black, sometimes brown, and with brown or hazel eyes. The Kashmirians, who occupy a basin of the middle mountains, at an elevation of 5,200 to 7,000 feet above the sea and in latitude 33° to 34½° N., though fine specimens of the Aryan type, are not so light in color as the

* The Northern Barrier of India. By Frederic Drew. London, 1877.

Dârds; but they are somewhat lighter than the Dogrâs, who occupy the foot-hills at an elevation of 3,000 feet above the sea, in latitude 32° to 33½° N., and are described as of a comparatively light shade of brown, darker than the almond husk, which is the color of the women, who are less exposed to the sun and weather. They have a good countenance and a hooked nose. Still darker shades are found among the high caste Brahmans of the lower plains. The Aryan peoples, who still inhabit the high valleys and slopes of the northern declivities of the Himalayan ranges, in Kashgar, at an elevation of six to nine thousand feet, and in the high valleys of the Oxus and Jaxartes, and thence westwardly into Persia, are described as white peoples more or less fair. It is scarcely possible to resist the conclusion that we have here a demonstration of the effect of elevation and climate on color, in the course of long periods of time.

The Aryans have generally been regarded as indigenous to central Asia; but the Semitic peoples have been supposed to be indigenous to the areas in which history has found them. But recent researches indicate that they descended into the valley of the Euphrates from the direction of the Armenian Mountains, or possibly from the direction of Susa and Persepolis, and intruded upon older populations (first) of the brown race in lower Babylonia, and (second) of the Turanian stock from northern Asia. They would seem to have moved westwardly, like the later Aryan streams, between the brown race on the south and the Turanian streams on the north; and they are properly to be considered as a very primitive branch of the white Caucasian stock. Their antiquity is so great that it is still a question among philologists whether their language was a primitive offshoot from the original Aryan stem, or whether it may not go back (like the Aryan speech itself) to some common monosyllabism, or word language, similar to the Chinese. However this may be, certain it is that all the Aryan-speaking peoples, as far back as historical or philological research has gone, are found streaming westwardly in successive waves from the fertile regions of high Central Asia, Iranian, Assyrian, Pelasgian, Celt, Teuton, and Sclave, overlapping and mixing with the brown and reddish-brown races along the southern line of contact with them, from the mouths of the Indus and of the Euphrates into Arabia, northern Africa, and southern Europe. The Turks are a mixture of the white type with the more northern Turanian stock. The more northern streams, surviving in the Ugrian Lapps and Finns, Maygars, Bulgarians, the pre-Semitic occupants of Chaldea, and possibly the primitive people of ancient Etruria* in Italy, would seem to have been still older migrations of peoples belonging to the more ancient Turanian race and language. The oldest people known to history in Mesopotamia was the brown-colored race, which is traceable from Hindustan to northern Africa and southern Europe. They built the oldest cities in lower Babylonia. The Bible affords some glimpses of them under the name of Cush. The aboriginal reddish-brown Egyptians must have belonged to this brown band of color. They were not negroes; nor do they exhibit a more distinctly marked negroid type than some other brown varieties; but probably some negroid affinities may be due to intermixture with the black race.

There is as yet no certain evidence of the existence of any white race in Europe before the advent of peoples which may be identified as of the same type and stock as the later Aryan and Indo-Germanic peoples. The Palæolithic men have been likened to the Australians and Esquimaux in condition and mode of life; but there is nothing whatever to show of what type or color they were. The same is true of the Neolithic brachycephals: their skulls assimilate them to the brown race. The Neolithic skulls of the race of Cromagnon approach nearer to the Caucasian type, but anatomical differences distinguish them from all modern men. There would seem to be nothing in what is yet known of them to justify an inference that they belonged at all to the same type or color as the known white race; or, if they did, it is not impossible that they may have been a wandering offshoot from the same Himalayan region at that primitive period. Their great antiquity and the isolation of their geographical position among inferior types which show affinities with colored races, would rather indicate that they were themselves a colored people, than that they were the ancestors of any white people whatever, and, much less, that they were the progenitors of the Aryan peoples themselves. All facts yet known tend to demonstrate that the white type moved westwardly from central high Asia. Yet

* Etruscan Researches. By Isaac Taylor, M.A. London, 1874.

there may be some possibility that, at a very remote epoch, it extended along the mountain ranges from the Himalayas to the Caucasus and the Alps.

Geological considerations suggest that, in Miocene and Pliocene times, a much smaller area of land in Europe was permanently raised above water than now; that all northern Siberia was under the ocean, and the Arctic seas extended into the basin of the Caspian; that, as the continent sunk on the south, northern Siberia was raised above the ocean; that Russia, Sweden and Norway, and Great Britain, were at times mere islands, and a large part of Germany was under water; and that the European area was much less adapted to human habitation than the higher parts of Asia. In the greater elevation, colder climate, and peculiar conditions of high central Asia (not the most elevated and barren plateaus, but the fertile river valleys and well-watered mountain slopes, which are still the seats of very ancient white peoples), operating, as it well may be, from Pliocene to recent times, we may find a sufficient explanation of the changes of form and color which make up the difference between the white type of this northern area and the more or less colored races of southeastern and northeastern Asia. The Miaotse now living on the eastern Himalayas are described as a white people, speaking the Chinese language. Such causes and conditions must have been less opertive in the European area in the preglacial times, when warmer temperatures prevailed over those parts of it that were likely to be occupied by the earliest men. But the greater elevation of central Asia might give rise to a colder climate and quite different conditions in Pliocene times, though that elevation were then considerably less than it now is.

This eastern derivation of the white race is confirmed by all that is known of the language, myths, and superstitions, common to all the Indo-Germanic peoples, and traceable back to a date long anterior to the later development of the Vedic and Zend-Avesta religions in Asia. It is still more strongly confirmed by the fact that so many of the domestic animals, the cereals, and the cultivated fruit-trees, were first brought into Europe from central Asia, their native habitat; though Prof. Heer found that many of the plants and seeds discovered in the Swiss lake-dwellings more nearly resembled those of Egypt and northern Africa than those of Asia. It appears that bronze first came into Europe from the southeast. Bronze implements were introduced into Scandinavia (according to Baron Kürck) among a people of the stone age by an intrusive people possessing domestic cattle and horses. The same appears to be true of all the rest of Europe. Horses and camels were first introduced into Egypt and Africa from northern Asia. Jade has been found in the Swiss lake-dwellings and in Neolithic deposits in France. Dr. Broca thought it came from China; but quite as probably it came from the Himalayan heights between Thibet and Khotan, whence the Chinese have obtained that mineral from the earliest dates known to their history. It is certainly not impossible that jade may have been brought into those localities by a pre-Celtic, or even a pre-Semitic, wave of the white race from that primitive centre of their origin. Thus, the progress of discovery contradicts the hypothesis of the late M. Omalius D' Halloy that the Aryan peoples had their first origin in Europe, and carried the common language eastward into Asia at a comparatively recent epoch; for, if we go back in time as far as science now requires, no reason remains for supposing (as he seems to have assumed) that, if the Aryans first came into Europe from Asia, they must have brought with them the Vedic, or Zoroastrian, religious culture, which really had its origin among them in Asia at a much later period of their development.

In general, the darker colors prevail in low, moist, hot climates, and near the ocean; and the lighter colors, in high, dry, mountainous, and cold regions. This is more and more confirmed by recent observations. Livingstone found it so in Africa. Doubtless, numerous exceptions may be pointed out on a minute examination into the colors of existing peoples in any part of the world; but the general fact remains. Such causes and conditions do not seem to have produced a like degree of difference in color on this continent since it was inhabited by the Indians; yet considerable differences exist. The portions of the continent first inhabited by them were most probably the coast regions, but little elevated, forest-covered and moist, and principally in the tropical latitudes. The existence of very ancient shell-heaps along both the Pacific and Atlantic coasts indicate a resort to the sea. The high mountain basins may have been occupied at a later period. The Esquimaux, a very old survival, driven into one cold extreme, are rather lighter than the Indians generally; and the Fuegeans, another old survival in the opposite cold extreme, are recently described as of a deep yellow color. This fact is quite analogous to the yellow color of the Hottentots, an old survival at the colder extremity of Africa. The ancient Mexicans and Peruvians of the high plateaus, though in the tropical zones, were probably lighter than the lowland tribes. Montezuma is traditionally represented as of a light yellow color. The Botocudos and some other tribes are yellowish. The Yuracarus of the eastern slope of the Andes are reported to be of a light yellow shade. Lighter shades appear among many scattered tribes in both North and South America. Mr. Darwin, on observations made upon existing peoples, fails to find satisfactory proofs that climate changes color, and he resorts rather to sexual selection. But it is not so clear that climate and elevation, operating through a geological epoch, have not had as much to do with color as sexual selection, effective as that may have been. Sexual selection is made to depend upon standards of beauty according to prevailing notions of beauty operating upon an inherent tendency to variation. It is at least singular that the black, brown, yellow and white standards of beauty should have been adopted in these several zones of latitude and courses of distribution, so nearly in keeping, on the whole, with the climates and conditions existing in the several areas of primitive occupation. Doubtless, sexual selection would increase the tendency to variation when once begun; but we seem to need some cause for the beginning of the variation; and so far as this tendency may be considered as the result of the environment, and of co-operative conditions, it would seem most probable (and so thinks Mr. Spencer) that these conditions are to be sought in climate as determined by elevation, winds, temperature, and dryness or moisture; but modes of life and inward causes may have operated as well. Mr. Darwin speaks of this tendency to variation as "spontaneous." Spontaneous movement is doubtless an efficient cause, but, being a subject that properly belongs to metaphysics, it cannot now be discussed. But, in a merely physical point of view, it may be observed that there is certainly a great difference in the internal processes for the production of heat in cold and in hot climates, and that a corresponding difference of physical activity and mental capacity is manifest among the different races of the earth, with the exception perhaps that the greatest extremes are alike unfavorable to the human development.

It is generally believed that America must have been peopled from the other continent; but whether by the northwest passage, or by the northeast, or by some southwest passage by the Pacific islands, or by a sunken continent, is still a question. The existence of wide and deep seas between the Pacific islands and South America within all the human period, if not from the earliest geological times, must have rendered that way of passing impracticable for the most primitive men. It is possible that after boats came into use a few individuals would be occasionally drifted by winds and currents, or they may possibly have rowed, to the American shores. The Sandwich Islands were probably first peopled in this way at a date quite recent in comparison with the first population of either continent. Many of the islands of both the Pacific and the Atlantic oceans were uninhabited when first discovered. Casual arrivals of a few individuals in a country inhabited by a strange race cannot change the characteristics of that race: they soon perish, or are absorbed. No doubt, such arrivals on the Pacific coasts have taken place in modern times, but the first peopling of the continent cannot be explained in that way. The attempts hitherto made to derive the red Indians from Asia by Behring's Straits have never been satisfactory, and for the reason that they were supposed to have come from northern Asia, and in quite recent times. The manifest insufficiency of this hypothesis to account for existing differences between the peoples of northern Asia (with the exception of the Arctic tribes on either side of the straits) and the American Indians, and more especially the older and more civilized populations of whom very ancient monuments remain, has led some other writers to look for an Asiatic origin by way of islands or continents in the Pacific ocean. Some strong reasons grounded on certain resemblances of form and character, ancient structures, religious rites, and language, as well as type and color, have been given in support of this view; but the difficulty has been to find a means of passage. The light to be derived from a due appreciation of the geographical distribution of races in geological time seems likely to reconcile these apparent contradictions and help to remove the difficulties. The certain fact that the Asiatic continent extended southeastwardly to New Zealand, or to Australia, in Tertiary times, may give some countenance to the idea that some land, or islands, within the human period, approached nearer to South America than they now do; and the existence of sunken stone buildings on the southeastern coasts of Asia and on some Pacific islands, and some resemblance of construction and style of art between the most ancient stone structures of Java, Ceylon and Central America, have been noticed in confirmation of it. But when it is considered that the recent soundings show a general depth of 2,000 to 3,000 fathoms over the whole ocean between them, the hypothesis becomes extremely improbable, though an elevation of somewhere near that amount, within the Tertiary period, might not greatly surprise a geologist. But an emergence of the continental shores of Asia sufficient to join the continents across Behring's Straits, inclusive of Japan and the Aleutian Islands, is not only geologically probable, but a due consideration of the distribution of both animals and plants demonstrates that such must have been the fact in Miocene times and even as late as the Pliocene, and while warm temperatures continued in that latitude. A comparison of the fossil plants of the island of Sachalin and of Alaska, belonging to the Miocene and Pliocene, confirms this view.* And here we may find an easy passage by continuous land for peoples of the brown band of races from southeastern Asia into North America as early as the Pliocene period.

The case is somewhat similar on the Atlantic side. Wide and deep seas must have existed between the two continents from the earliest geological periods. The recent soundings, however, show that a continuous land connection between northern Europe and northeastern America may possibly have existed in the Miocene, or even as late as the glacial epoch; and other evidences confirm this hypothesis. The myth of a sunken Atlantis is too recent to deserve attention; but the other continent may have extended to the Madeiras, the Canaries, and the Cape Verde islands as lately as the glacial epoch. It appears by the soundings of the "Challenger" (*Map in the "Nature," No.* 383) that an elevation of 1500 fathoms would make the Madeiras the point of a peninsular extension of Portugal and the Canaries a headland of Africa, with

* *Miocene Flora der Inseln Sachalin*, by Prof. O. Heer, p. 6 (1878); Mémoires de l'Acad. Imp. des Sciences de St. Petersbourg, T. xxv. No. 7.

a deep gulf between. The same soundings further show (*Map in the "Nature," No.* 391) that at a depth of from 1,000 to 2,000 fathoms there is a ridge along the bottom of the North and South Atlantic ocean, near the middle and in some near conformity with the shores of the continents, of which the Azores, St. Paul's, and Tristan da Cunha, are peaks still rising above water, with depths reaching to 3.000 and 3,450 fathoms on either side. It is possible that the American continent extended further eastward than now in the region of the West India islands in Tertiary times. The distribution of animals and plants (according to Mr. Wallace) furnishes some evidence of such an extension. But if the possibility of crossing the Atlantic (even if the bottom ridge in the middle had been raised above the ocean) be not entirely excluded for all prehistoric peoples, it may still be considered as absolutely impracticable for the most primitive men, and until times long subsequent to the first peopling of this continent. If it had been possible for the Guanches, or any other people of the brown band of races, to cross the ocean in prehistoric times, any such mixture, considering the near identity of type and genetic origin of the two branches of the same stem, would have produced little or no change in the red Indian race. It is perhaps not improbable that the glacial men of New Jersey, retiring northwardly, may still survive in the Esquimaux. But for the rest of the American red race (if indeed they belong to the same race at all), it is far more probable that the actual route by which they reached this continent was by the passage in the region of Behring's Straits; and such passage must have taken place as early as the Pliocene period.

In this view, the discovery of human remains in the Pliocene of California becomes the more credible, and confirms the hypothesis. It is supported by a general consideration of the geographical distribution of the Mammalia in Tertiary times. Prof. Huxley has shown the importance of taking into view the existing configurations of land and sea in reference to the distribution of the Mammalia, and it can be scarcely less important in reference to the earliest migrations of the human races. The Elephants are known to have been native to the Palæarctic province. They must have reached America by that same land connection across the region of Behring's Straits. Fossil elephant remains abound near Escholtz Bay on the American coast, and they are traced along the Andean backbone of the continent into South America; but they extended no further eastward in North America, down to the end of the Pliocene period, than to the western shores of that extensive fresh-water Lake of the Miocene and Pliocene periods. But after that barrier had been cut off by a further elevation of the land, and in Postpliocene times, the Mastodon, with Man in company, appears to the eastward of it, and not before. It is in these same Postpliocene times only that the Megatherium, Megalonyx, Peccary, and perhaps other animals of South American types, are found within the southern United States, when both the ancient lake and the ocean barrier across the isthmus had ceased to obstruct their progress northward. Prof. Marsh has recently expressed the opinion that these gigantic *Edentates* had their first evolution in northwest America, and that they reached South America after the passage was opened over the isthmus in the Tertiary period, though their remains are more abundant in South America. This theory of their origin in respect of type would not, perhaps, be inconsistent with the supposition of a return migration of these larger species from South America into the United States in the later Postpliocene times. Prof. Marsh concludes that the Horse, Rhinoceros, Tapir, Camel, Pig, and Deer, were natives of the northwest territories of America, and that they passed into Asia over that same bridge of Behring's Straits; and that the Bears and Antelopes passed from Asia into America by the same way; but that the Sheep, Goat, and Giraffe, were stopped by the disappearance of the bridge before they could get over. The Camels (llama, vicuña, &c.), which appear to have originated in western North America, must have reached South America, in like manner as the Mastodons, by the passage over the isthmus, after the barrier was removed; and they are to be regarded as survivals of the type in that area. The Pliocene men could easily reach South America by the same route. And, in like manner as they reached the eastern portion of North America, they would readily extend to Brazil and Guiana when those areas ceased to be islands separated by wide ocean barriers from the Andean ridge. In later times, they would easily reach the West India islands from both North and South America. Human remains have been found in Brazilian caves, and in Buenos Ayres, together with the bones of extinct animals of Postpliocene age.

There would seem to be good reasons for believing that the Rhinoceros, Camel, and Horse, had their first evolution into these types in western North America, and that they passed into the Palæarctic province in Tertiary times. The recent discoveries of fossil remains in the western Territories of the United States, in the hands of our palæontologists, furnish a more complete history of the evolution of these types than is found in any other part of the globe. Both Rhinoceroses and Elephants are found in the Tertiary of Europe, Africa, and southeastern Asia, and they may have passed either from or to America by this same route. Fossil horses have been found in South America, and they have been reported from the Postpliocene deposits of the United States; but no rhinoceros, or camel, has been found to the eastward of that ancient Pliocene lake, in that or in any older period. Lemuroids are reported from the Eocene of these western Territories, and also forms having affinities with the apes. It would, therefore, appear to be certain, either that Lemurs and Apes had a distinct evolution in the Nearctic province also, or that in the Eocene these types extended from Europe to America. The Lemurs are extinct on this continent, but the Apes survive in Central and South America in tropical forests suitable to their mode of life. Remains of Apes, kindred in form to those now living in South America, have been found in Brazil together with those of extinct Postpliocene animals. It is pretty certain that they passed into South America from the north after the Miocene ocean barrier across the isthmus had disappeared. They differ so much from the old-world Apes as to demonstrate a very remote branching from the same stem, even if they did not originate independently on this continent. No anthropoid forms have ever been found among them on this continent, fossil or living. Zoölogically, the human type has much nearer affinities with the Catarhine Apes of Asia and Africa than with the American forms. It is, indeed, just as possible that the American Lemuroids and Apes had an independent evolution from lower types of animals on this continent as that the same thing should take place in the Palæarctic province. But the first existence of Man in America is sufficiently accounted for by the supposed derivation from Asia.

It would, therefore, appear most probable (if not quite certain) that the Pacific coasts from the Aleutian Islands to the isthmus were peopled by the ancestors of the red Indian race before the region to the eastward of the Sierras and Rocky Mountains was occupied by them. The ocean barrier at the isthmus once cut off, the Pliocene men would readily follow the mastodons and camels to the western coasts of South America, and thence ascend to the higher plateaus and spread over the eastern slopes of the Andean ridge. It is along these coasts and in the lower lands of Mexico, Central America, and Peru, that the oldest remains of fixed habitation and civilization are found. Not that these remains were the work of the very first settlers, or of peoples that were then migrating from the north; but that these remains may be taken as some evidence that these parts of the continent had been the seats of longest occupation, where higher stages of progress had first been attained to. The oldest of these civilizations must have been quite recent in comparison with the first date of human occupation: those of the elevated basins of Mexico and Cuzco were still flourishing at the discovery of America. The older seats of civilization in Central America had been abandoned long before the arrival of the Spaniards. When the earthworks of the Ohio Mound-builders were first discovered, they were covered by ancient forest growths, and showed the same signs of high antiquity that they now do. These earlier peoples and civilizations appear to have spread northeastwardly from Central America over northern Mexico and into the valley of the Mississippi; whence their successors seem to have retired southwardly, again, at a more recent period, or to have become extinct in that area when more barbarous tribes pressed down upon them from the northern regions. There is nothing yet known by which it can be determined whether the most ancient Mound-builders of the Ohio valley, or the Stone-builders of Palenqué and Uxmal, were the more ancient; but the simpler earthworks and ruder implements of the former would seem to indicate a lower stage of progress, if not a higher antiquity. The mounds and other remains of towns in southeastern Missouri and in other southern States, and especially the pottery and other implements found therein, indicate a period much more recent than that of the earthworks of the Ohio valley; and they exhibit a stage of progress in arts and mode of life which still survived among the Natchez and other southeastern tribes when the country was first explored.

We have still to search for the first place of origin of the human form. There would seem to be no sufficient ground for the conclusion that the human type first appeared exclusively in southeastern Asia, or within the ORIENTAL province; for at the same time when the oldMalayan peninsula stretched southward to Australia, the more southerly extension of the continental shores must have continued around to South Africa; and it is just as possible that synthetic anthropoid forms were evolved into types that might be called human in one part as in another of that whole area, and even as far north as France where the Miocene *Dryopithecus* could live. As yet there are no proofs by fossil remains within that area (in Europe or elsewhere) of the actual existence of forms intermediate between the anthropoid apes and the lowest known human form; unless that lower type of human skull of the Neolithic epoch, of which the Neanderthal skull is cited as an example, can be called intermediate. Even if such intermediate forms should be discovered in Europe, it would not necessarily follow that the Palæolithic men of the flint implements, whether they were of the white or the colored race, were the direct lineal descendants in that area of any such inferior primitive types; for such more primitive forms may very well have become extinct in that area long before the advent into Europe of those Palæolithic men; and the argument would still remain in full force that the white race received its complete distinction in high Central Asia latest in the order of evolution of new forms and colors from darker to lighter, and in an order of distribution from south to north. Such primitive extinction of intermediate forms in the more northern areas would be quite analogous to the extinction of the anthropoid apes in those same areas, as the survival of the Negro type in the more southern provinces is analogous to the survival of the anthropoid apes in Africa and in Sumatra. No remains of such intermediate types having been found in Europe or in India, it has been inferred that they are to be looked for in more southern tropical regions, or in some submerged "Lemuria." As these earliest progenitors had not as yet manufactured stone, flint, or other imperishable implements, and as their bones would in all probability have entirely disappeared, unless fortunately preserved in rare instances by complete petrifaction, the mere fact that no such remains have been found should not be very surprising. Nevertheless, it may very well be true that while all known races may be lineally and geographically traced backward to the southern tropical provinces, it may at the same time be the fact that the unknown ancestors of all of them may have extended northwardly far into the Palæarctic province, in times preceding the Miocene men of Thénay, in the same way as did the living anthropoid apes, and in the same way that the lemurs of Madagascar and Celebes go back to Eocene progenitors, which then lived as far north as the Palæarctic areas. Among these earliest human progenitors, it is certainly not probable that there were any white types or color.

There are, properly speaking, no white-skinned, blue-eyed, and light-haired apes, though it appears that the naked parts of the face in some of them exhibit black, blue, red, brown, and even whitish colors, and some of them have white and reddish whiskers. Under the merely animal conditions in which they lived, it might be the more probable that such spontaneous tendencies to variation as might arise would be favored by sexual selection for ornament and attraction as in lower animals; and this operation may reasonably be supposed to have continued through the earlier stages of the human development; but Mr. Darwin himself admits that the stronger kinds of evidence, to show that the light color in men arose from sexual selection, are wanting. He gives many facts to prove that every race considers its own color the most beautiful; but this may be attributed to a merely fashionable way of thinking after the natural fact has come to exist. Colored races which still occupy latitudes and climates where they probably originated, do not seem to have grown lighter in recent times, unless crossed by races of lighter colors. But though it is neither proved, nor probable, that the white color existed among the earliest progenitors, and whatever may have been the cause of the difference of color, or however color may be regarded as a secondary character, from the general fact that the principal bands of color correspond so nearly with the other distinctions of race and habitat, it may safely be inferred that the origin of the different colors must go very far back in the evolution of races. It is hard to resist the conviction, for instance, that the Chinese, who have occupied their more northern and inland area for a geological epoch, aside from recent mixtures with more northern peoples, have not grown considerably lighter than their early ancestors were, in spite of any notion on their part that their own actual color was the most beautiful of all. And the fact is certain that the peoples of the more elevated and colder regions show a universal tendency to lighter colors of the skin, hair, and eyes, the colder the latitude and the more elevated the country which they inhabit.

It is forcibly argued by Mr. Darwin that the earliest semi-human tribes were both bearded and hairy, and that their successors, in course of time, by sexual selection, became more and more naked and beardless. Whatever the cause, the fact seems to be so, generally, with all the colored races to the present time. In this characteristic, the red Indians share with the Mongolian and Malayan populations. At the same time, they exhibit such well-marked differences in color, in the high nose, in the forms of the skull, and other peculiarities, as to distinguish them now from all other races of men. And this fact would certainly argue a separation from them for an immense length of time, if not an occupation of this continent since the beginning of the Pliocene period. Except the Ainos (most probably an isolated survival from a very ancient origin), the white race is said to be the most bearded and hairy of all. The suggestion of Mr. Darwin, that this character is due to a later reversion towards a primitive characteristic in the semi-human progenitors of all, is at least not inconsistent with the theory here maintained, viz., that the white race and color received its distinctive development from approximate types of darker shades growing lighter and lighter as in the course of migration from lower latitudes and levels they ascended to the high fertile valleys of Central Asia; not suddenly, but as the slow effect of the climate and conditions (together with inward causes) operating through a geological epoch, in which sexual selection may have continued to have some operation.

What is thus brought to light, concerning the known races of men, would seem to indicate in general a distribution of black races southwardly into Africa and Australia; of brown races, westwardly into northern Africa and southern Europe, and eastwardly into the Pacific islands and America, on either side of the

Himalayan mass of mountain elevations; and of the yellow races, northwardly, along the eastern coasts and over the high plateaus of northern Asia; and of the white race, westwardly, from the high valleys of central Asia — all from the direction of southern Asia: but when the question is of the first origins in the Eocene period, or before the Himalayas were lifted up, it is apparent that the earliest progenitors of all may have extended from Australia and south Africa even far into the Palæarctic province. The question in what precise locality the human form first appeared within this whole area, however interesting the inquiry, would seem to be of little importance, unless it were to be assumed that Man must have originated in one place only, or from one pair only. Whereas it becomes apparent, if well considered, that such could never have been the case; for it was never possible for men to exist, any more than apes or other animals, otherwise than by pairs, families, tribes, or nations. It takes man, woman, and child, to constitute one whole human person that can continue to live, or to change in respect of type of form. The species, the genus, only continues: the individuals perish out of the field of nature. Any peculiarity that might arise in the growth and development of the individual could be transmitted only through the pair; and it requires but little counting of ancestors on both sides, or of descendants, whether marriage were by pairs, by tribes, or by *gentes*, to discover that, in the endless interweaving, any such peculiarity, if continued at all, must soon be communicated so widely, that all become related and share the distinction more or less; and the distinctive peculiarities so arising must come out at last, in each group, or tribe, as the expression of that ideal form or type, common to all, which we call a species, a variety, or a race.

But can mere cells or atoms of their own motion form, or express, ideas? It would seem to be necessary that whatever elements, pangenetic germs, or atoms, go to make up the individual form, or the specific form, must be suspended from the idea in nature which holds them together in unity as one whole thing;—as inevitably as the particles of color which make up the picture are suspended from the idea of the painter. In either case, it is done through intermediate instrumentalities.

It is evident that many pairs, families, or tribes, must have existed all at once at any conceivable time, and been spread over some considerable area; just as the pairs and species of apes now exist, and always must have existed since they were apes at all. That change of form in which lies the ascent of type that is transmitted must take place as a gradual transition along the branching ideal thread of embryological evolution, in whatever lines of distribution over space: it cannot be and continue in one individual, or in one pair only, but must come to exist simultaneously in many or all at once. So that wherever in the course of evolution and new creation of artistic type of form (for every new form is a new creation), a type appears which would unhesitatingly be pronounced human, we may be sure it would not be in one individual or in one pair only, but in a whole tribe of pairs, if it were to survive and be continued. It is apparent that this might take place over one widely extended area, or simultaneously in two or more widely separated areas, or in one quite limited area only. In either case, if we go back (as zoölogical science requires) to the beginning of the whole order *Primates*. we might expect to find (what appears to be the fact) that the synthetic ordinal type of the common ancestors of all mankind and of all ape-kind existed simultaneously in the Palæarctic, Nearctic, Oriental, and African provinces alike. But since it appears that the anthropoid apes once extended from France to Borneo and South Africa, the same may just as well have been true of the most primitive human progenitors; and the transition from ape-like creatures to the distinctly human form might be as likely to take place in one part as in another of that whole area; and it may have taken place, and most probably did take place, in many parts, contemporaneously, but with differences in the several distinct areas analogous to the differences which distinguish the different species of apes, fossil or living, in those same areas, and resembling the differences which still distinguish the existing varieties of mankind.

Considering the human race from that first beginning when it became distinctly human in form and faculty, it is manifest that there must have been such an enormous succession of generations, tribes, and nations,—such continuity of new creation and extinction, of migration and commixture, in whatever branching directions of evolution and distribution, "in that dark backward and abysm of time," that any accurate or complete tracing of them, in respect of lineage, language, or first centres of origin, must be deemed impracticable and utterly hopeless. Theoretically, there may as well have been two or more centres of origin as one only: it is simply a matter of fact to be ascertained as nearly as possible.

We begin with an ethnographical description of peoples as they now are; we study them, ethnologically, in respect of race or natural lineage, and anthropologically, as a part of the animal kingdom. We mav trace them as peoples, or nations, as far back as they have a national history, and as races as far back as we can find materials for a natural history, and as man as far back as zoölogical science may admit. But at both ends alike of the evolutionary lines and process we find ourselves unavoidably entering upon the higher sphere of the intellectual, artistic, and moral—into metaphysics—a kind of knowledge that is, after all, not only the highest and the first, but the most certain and important of all. The terms *physics* and *metaphysics*, like the words *natural* and *supernatural*, are commonly used ambiguously: if physics be taken to mean only what can be perceived by the senses, then metaphysics may properly mean what can be seen only by the mind; but, of course, if physics be taken to mean both kinds of knowledge, then there might remain no other use for the term *metaphysics* than to express that absolute nothing that lies beyond all *physics*. And just so of natural and supernatural.

The progress of science may enable us to gain an insight into the mode, manner, and law and fact of the process, if not into the time and place and cause of it. Only the most comprehensive philosophy can ever enable us to form an adequate conception of the nature of that cause, or creative power, which could produce such a work in any manner, at any time or place, under any conditions, or under any law whatever. Taking the whole into one view, and contemplating the almost infinite series of changes that have taken place in geological time and over successive surfaces in space, the notion may just dawn upon the imagination that the ideal series of forms which actually existed in nature as a process of thought in creation, is, by the power of thought in us, merely shifted round, as it were, from the Mind of Nature into our minds, however imperfect the reminiscence in us.

Zoque—the Language spoken at Santa Maria de Chimalapa, and at San Miguel and Tierra Blanca, in the State of Chiapas, Mexico.

By Antonio de Coruna y Colludo.

(*Translated from the author's manuscript, by J. A. Dacus.*)

THE ZOQUES.

The Zoques, once a numerous and powerful nation, with cities and towns in all of the isthmian states of Mexico, extending from Tehuantepec through Tobasco and Chiapas into Oaxaca, and some assert even farther to the north and west, have been reduced by wars and conquests until they number no more than 2,500 or at most 3,000 souls. Their present country is a small mountainous district, including two mean villages, Santa Maria de Chimalapa and San Miguel. Very recently another settlement has been made by the Zoques on the road passing between Tarifa and Santa Maria, near the banks of the Arroyo de Otales.

The Zoques are esteemed to be the immediate relatives of the Mijis, a still more numerous race. But the race likeness is not preserved in the language. The Mijis and the Zoques speak languages scarcely related.

They are not a handsome people, but are represented as industrious and enterprising. They manufacture cotton goods and pottery. They cultivate indigo, maize, and cotton.

They were conquered, about two centuries anterior to the discovery of America by Columbus, by the Chiapanecs, and have ever since remained a subject race. A considerable number of them now speak the Spanish language.

Their language belongs to the Maya-Quichè family of Southern Mexico and Central America, and appears to be most nearly related to the Tzendal-Maya, which has been regarded as the parent language of the Yucatec peninsula—the tongue spoken by the builders of Palenque, Chi-chen, and Itza. It is written by using the following letters of the Roman alphabet:

a, b, c, gh, e, i, j, k, m, n, o, p, q, u, s, t, u, y, tz, z, and **h** as an aspirate.

The Pater Noster in Zoque.

Theshata tzapquesmue itupu yavecotzamue mis nei, yaminè mis yumihacui ya tuque mis sunoycui, yecnasquesi tzapquesmuese. Tesanè hoimuepè homepe tzihete yshoy yatocoyates mis hescova hes jaziquet mis atocoipasè thesquesipue jatzi huitemistetzaen hocysetè cuijomue ticomaye ya cotzocamisthe mumuyatzipue quesi, tese yatuque.

A Vocabulary of the Zoques of Santa Maria de Chimalapa.

A.

AH-KUM. Squash, gourd, melon.
AH-MA-PA. To see, to look, to gaze.
AH-PU-AM. Old, ancient, long-existing.
AH-TO-E. Language, speech (see *O-to-e*).
AN-WA-TZI. Beard, bristles, hairy.
ATO. Elder, the father, originator.
ATZI. My elder brother, the first born.
A-SUH. Musquito, zincuda, a poison fly.

B.

BAH-HOK. River, wide stream, channel.
BE-AH-KU. Wild-hen, turkey.
BE-OK-SINQUES. Small, diminutive.
BEN-NE. Man, people, the whole race.
BE-TUM. The eye, faculty of vision.
BU-EH. The ankle, lower limb.
BUTZ-BUTZ. Orange color'd, yellow.
BU-AN-PA. To sing, to make melody.

C.

CA-APE-UH. That, the other thing.
CA-HA. There, in that place, yonder.
CA-UM. Dead, not living.
CA-NÀ. Salt, salt water.
CHICK-SHAH. Lad, boy, youth (*un jóven*).
CO-HE-KA. Fish (a generic term).
CU-CU. A pigeon, a dove.
CUM-CO-E. Town, city, village.
CU-EH. A tree, the trees in a forest.
CU-E-NA-KA. Bark, rind of fruit, nutshell.
CU-MÈ. Vast, great, powerful.
CU-TZCH. A hill, a height, a mountain top.

E.

E-NE-EH. Who, that, that one, which.
EPS-KO-NA-KAN. Thirty, thirtieth.
EPS-SHAN. Twenty, twentieth.
ETZ-PA. To jump, to dance with joy.

G.

GA-È. To-day, at the present, now.
GUE-HE. Here, at this place.
GUEN-HEN. Good, excellent.
GO-MAS-U-NA. Girl, lass, maiden.

H.

HAT-TÈ. The human race, the ancient people.
HA-TA. My father, the father, the one before.
HA-YA-AH. My husband, the master.
HA-MOH. The red race, the aborigines.
HA-MUH. The sun, father of the Indians.
HA-MA-HI. Daylight, not dark.
HA-MAH-ANK-SHAN. The dry season, the season of sunlight.
HUEN. Prairie, treeless plain, great meadow.
HUE. Yes, affirmation, truly.
HECH-PA. Living, having life.
HUE-HEN. An insect, *rodador*, a fly.
HO-EHN. Having wings, winged, a bird.
HO-HE. To-morrow, in the future.
HOH-HE. The day-dawn.
HU-KU-TA. Fire, flame, heat.

I.

I-È. Foliage, leaves, laminæ, folds.
IUK-POI-PA. To make haste, to flee as from the presence of a foe.
I-E-KA. Deep shadows, the dense shade of a tropical forest.

J.

JA-ZI-QUE-UM. Evil-minded, bad nature.
JA-ZI-QUE. Offenses, debts, obligations.
JOSH-PA. To labor, to struggle, to toil.
JA-KU-AH-PA. To slay, to destroy, to murder.

K.

KEN-PACK. The forehead, front part.
KEN-NAH. The nose, nasal.
KEN-TZCHUS. The finger nails, claws, talons.
KEN-OCK. Sandals, a kind of shoe, foot protectors; hence footways.
KEN-OI-PAH. To eat, the act of eating.
KO-TZCH. A hill, a sloping mountain.
KO-MEH. Grand. majestic.
KO-HE-KA-YE. The red snapper, a species of fish.
KU-AI. Woodlands, forest.

M.

MA-AT-ZA. A star, a distant light, a twinkling thing.
MAK-TA-SHÀN. Four, fourth.
MAK-TU-TAN. Nine, ninth.
MAK-TU-MA. Eleven, eleventh.
MAK-KAN. Ten, tenth.
MAK-KU-ES-TA-KAN. Twelve, 12th.
MAK-TAPS-HAN. Eighty, eightieth.
MAK-TAPS-KO-MAK-ÀN. Ninety, ninetieth.
MAK-EPS-HAN. One thousand, thousandth.
MAYS-TZAN. Two, the second.
MA-MA. My mother, the mother.
MAN-KU-EE. The foot.
MAN-KU-EE-YU-KEE. The toes, the roots of trees.
ME-AH. The sea, the ocean, great salt lakes.
MEN-YEN. Thundering, booming, beating of the billows against the shore.
MEN-AH. The American deer, mountain sheep or antelope, game.
ME-UN-PA. To come, to arrive.
MAK. Indian corn, maize.
MUK. Grass, the grassy plains.
MOR-SHAN. Five, fifth.
MORS-EP-SHAN. One hundred.
MO-UN-PA. To sleep, to slumber.
MUM-MU-YA-TZI-PUE.
MIS.

N.

NAS. The earth, the soil, the land.
NA-AC-KO-TENCK. A skin lodge, a native hut.
NEI.
NEN-PEN. Bloody, gory, red color.
NEY-TZU-HE-TE. Early morn, the dawn.
NE-AH. Water, a pond or lake.
NEN-AH. Bad, evil disposed.
NUEC-PA. Warm, summer heat.
NOTZ-PA. To go, to take leave.
NU. A dog, a coyote, a wolf.
NUM-PA. To steal, to plunder.

O.

O-TOE. Language, speech, oration.
O-TON-PA. A conversation, a discussion.

P.

PAK. A bone, a shell-covering, a skeleton.
PA-HOK. A river, broad stream, a channel.
PA-HO. The wolf, the black wolf.
PENCH. Feathers, down.
PO-HOH. Bright, shining, white, glaring.
PUTZ-PUTZ (see *Butz-butz*). Orange color.
PU-EH (see *Bu-eh*). Leg, lower limb.
PU-MAH. Strong, powerful.

S.

SA-HEN-PET-KUI. Bow and arrows.
SA-AH-HEN. Snake. a reptile.
SA-AH-KU-KAH The rattlesnake.
SA-AH. Wings, winged creatures.
SUE-TZEH. My elder sister, the elder one.
SCHEN-HEN. Many, a multitude.
SHAH. The arm, branch of a tree, inlet.
SHA-PA. The moon, the night sun.
SHAN-NAH. The wind, a gale, a storm.
SHEES. Flesh, meat of the iguana.
SHEEK-PA. To laugh, express joy.

T.

TA-A-TZENK. Ear, auricular appendage.
TA-A-PUE. Personal pronoun, *he*.
TCHIN. Pine, any coniferous tree.
TEYN-MAN-NU. My son, offspring.
TENTZ. The teeth, tusks of animals.
TENK. House hut, tent, dwelling-place.
TESE. Thine (applied only to the Supreme).
TE-SA-NE. Sanctified.
TEN-PA. To stand. to remain.
TENK-EP-SHAN. Sixty, the sixtieth.
TENK-EP-SKO-MAK-AN. Seventy.
TEM-PA. The lightning, a scintillation.
THES-HAT-TA. Our high father.

TIM-NUE-HI. The name, appellation.
TO-O-TI. A tongue, a peninsula.
TO-MÈ. Near, close at hand.
TU-TAN. Six.
TU-DU-TAN. Eight.
TZOI-KOI. The chest, the thorax.
TZU-I. Tobacco.
TZAP-QUES-MUE.
TZI-HE-TE.
TZU-È. Night, darkness.
TZUEN-PA. To sit, to recline at ease.
TU. The dew, a drizzling rain.
TU-ANK-SHAN. The wet season.
TU-QUE. Food, the terrapin.
TUS. The first personal pronoun, *I*.
TU-MAH. One, the first.
TZECK. The abdomen, belly, a bellows.
TZU-TZI. The mammæ, a virgin's breast.
TZI-HE-TÈ. Daily, day by day.
TZI-HE-UN. The afternoon, evening.
TZU-MA. Snow, frozen water.
TZU. A stone, cliffs of rocks.
TZU-MA-QUE. A mountain, a height.
TZU-TZHUS. Sky blue, pale blue.
TZU-TZHAN. Dark green, sea-green.

U.

U-KUM. A cucumber, squash.
UP-SAH. Cloud, haze, mist, obscure.
U-I. No, a negative reply, not.
UK-OI-PA. To drink, to be drunk.
U-NA-A-PA. To lie, speak falsely.
UHP-SA-PA. Gloomy, dreary.

V.

VA-CO-TZUM-NÈ. High palace, heaven.
VAN-TI-VI-KI. Thumb, great finger.
VA-OK-SENK. Small, very little.
VAK-SENK. Young, of tender age.
VAK-SENK-KO-MAS-U-NA. A tender girl.
VAK-SENK-BEN-NÈ. Kind, tender people.
VA-I-E. Cold, chilled, shivering.
VA-KUS. All, everything, the whole.
VAN-PA. To sing; melody, music.
VAU-HOH-PA. To cry, to mourn, to weep.
VÀ-NÀ-KÀ. The face, the front part.
VI-TAM. The eye, power of vision.
VI-KI. The fingers, tendrils.
VI-AH-KU. The pheasant, wood-hen.
VENS-TU-TAN. Seven, seventh.
VES-TENK-EP-SHAN. Forty, fortieth.
VES-TENK-EP-SKO-MAK-AN. Fifty, fiftieth.
VIN-TU. The neck, a connecting link.
VIN-TZU-MA. The forest, wilderness.
VEHN-HEN. Youthful, recent, lately.

Y.

YA-VE-CO-TZAM-NÈ. The high dwelling, exalted heavens.
YA-MI-NÈ. To make great, to glorify, set apart.
YA-TA-CO-YA-TES.
YA-TU-QUE. Amen, be it so.
YA-HUE. For, because of, on account of.
YA-KA-U-PA. To slay, to kill, to murder.
YO-MA-U-NA. A young woman, a wench.
YUC-POI-PA. To flee away, to make haste, run.
YU-MA-HA-KU. The naming of, station, power.
YU-MA-HA-CUI.
YEC-NAS-QUE-SI.
YENK. Black, a negro, thick darkness.
YUE-PUEH. This, that, they.
YSH-OY. Debts.

Z.

ZIN-CA-DU. A species of musquito, a stinging insect.
ZU-MA. A wild-cat, the American tiger.
ZI-NA-KA. The papaya, a tropical fruit.
ZO-QUE. The men, the great brave race.

A brief Essay on the Southern Mexican and Central American Languages.

There are more than twenty-five distinct languages spoken between the isthmus of Tehuantepec and the isthmus of Panama. It has been claimed by some investigators that they are all intimately related, and constitute but one family of languages, which they call the Maya-Quiché, and mention the Maya-Tzendal as the oldest and the classic language of the family of tongues.

I know not upon what particular resemblances this claim is based. It is undeniable that there are similar forms in the structure of a number of the languages spoken by the so-called Maya-Quiché nations; but in vocabulary, in structure, and in other respects, the distance between the most nearly related of the languages spoken by the people who inhabit Yucatan and Chiapas is further apart than the English and the Swedish. Between some of the languages the resemblance is about the same as that between Chinese and French; that is, none at all.

The Zoques—a tolerably full vocabulary of whose language is here presented—appear to have no relationship with their immediate neighbors the Zapotecs, whose language appears much better developed, and is smoother and far more copious.

Let us take the words beginning the Lord's prayer in the several languages to be compared. Thus in Chañabal, spoken in Chiapas, the words for "Our Father" are *Tattic haya*. *Culchahan* signifies "the high heavens." In Chiapanec we find *Pua mangueme* for "our Father"; in Chol the same meaning is expressed by *Tiat te lojon;* while in Tzendal the words used to express the idea are *Tatic ta nacalat tachulchan*—"Our Father in the high heavens art, who." In the Zotzil the difference is still more marked; thus, *Totit ot-te nacal oi ta vinagel-utzilaluc*—"In the great heavens let our Father be." The Pokonchi is another language said to belong to the same family of tongues; the prayer begins thus in that speech—*Catat taxah vilcat.* A still greater difference is noted in the Maya language as spoken in the region of Palenque. The author of "Rambles in Yucatan" furnishes the following:

Cayum ianech ti caannob cilichthantabac akaba: tac a
Our Father who art in heaven, blessed be thy name; it may come thy
ahaulil ci okol. Mancahac a uolah uai ti luun bai ti caane. Zanza-
kingdom us over. Be done thy will as on earth as in heaven. Daily
mal uah ca azotoon heleae. Caazaatez ci ziipil he bik c' zaatzic uzii-
bread us give to-day. Us forgive our sins as we forgive their
pil ahziipiloobtoone ma ix appatic c' lubul ti tuntah, caatocoon
sins to sinners; not also let us fall in temptation, us deliver
ti lob.
from evil.

THE ZAPOTECA.

The Zapotecs are near neighbors of the Zoques, and the few thousands of this race still surviving are all that is left of the once populous and mighty kingdom of Zapotecapan, one of the ancient civilized states of America — a people which successfully resisted the armies of the allied kingdoms of Anahuac.

The language spoken by this race is far more copious, and susceptible of giving expression to ideas, than the Zoque, or indeed of any American language yet reduced to form, save the Otomi, the Aztec, the Tzendal, the Maya, and the Quiché-Cakchiquel, and possibly the Nagrandan and Peruvian.

The present seat of the Zapotecs is the eastern slope on the isthmus of Tehuantepec. Once they had cities and towns, and a semi-civilized social organism peculiar to themselves, extending over the entire region from Oaxaca to Tehuantepec. Of the language spoken by this people, the learned abbé Brasseur de Bourbourg says: *La langue Zapotèque est d'une douceur et d'une sonorité qui rappelle l'Italienne.* (B. de B. Esquisess, p. 35.) Burgoa is still more pleased with the language, of which he thus speaks in his "Geográfica Descripcion": *Su lenguage era tan metafórico como el de los Palestinos, lo que querian persuadir hablaban siempre con parábolas.*

Juan Córdova prepared a grammar of the Zapoteca more than a century and a half ago, but this author seems to have lacked the requisite scholastic ability for the proper execution of his self-imposed task. As yet a complete vocabulary has not been published. Señor J. Corona is now engaged in an effort to make this valuable addition to the stock of philological material for the student of American languages.

The sounds of the Zapotec language may be expressed by the following letters of the English alphabet: *a*, *b*, *ch*, *e*, *g*, *h*, *i*, *k*, *l*, *m*, *n*, ñ, *o*, *p*, *r*, *t*, *u*, *y*, *x*, *z*, *th*.

There are also five diphthongs, viz., *æ*, *œ*, *ei*, *ie*, and *ou*.

One of the peculiarities of the Zapotec language is that of expressing the plural number by the use of numerals, sometimes by adjectives. A Zapotec will say *pichina*, deer; but if he wished to designate a herd of deer, he would say *ziana pichina*, many deer.

Like the Aztec and other cultivated languages of the southern part of our continent, the Zapoteca has reverential terms, that is, terms of respect or of honor. This is accomplished by the use of different pronouns, or words employed as pronouns.

Naa, *ya*, *a*, (I) is used when equals speak to each other. *Lohui*, *loy*, *looy*, *lo*, (thou, etc.) *Yobina* (your honor), a word only used when speaking of superiors. *Nikani*, *nike*, *nikoe*, *ni*, *ke*, "he" or "they." The same system, as indicated, runs through all the declensions and inflections.

There are four conjugations of Zapoteca verbs; these are distinguished by the particles with which they commence.

FIRST.	Present, *ta*.	Past, *ka*.	Future, *ka*.
SECOND.	" *te*.	" *pe*.	" *ke*.
THIRD.	" *ti*.	" *ko*.	" *ki*.
FOURTH.	" *to*.	" *pe*.	" *ko*.

As a specimen of the written Zapoteca, I submit a *Pater Noster* from a catechism prepared by Leonardo Levanto:

Bixoozetonoohe kiiebra *nachiibalo* *nazitoo* *zirkani*
Father our heaven thou who art above great has been done
laalo *kellakookii* *xtennilo* *kita* *zuika* *ruarii* *niliziques-*
thy name kingdom thine will come here thy will,
lalo, &c.
&c.

The above is sufficient to illustrate the peculiar arrangement of words into sentences employed among the Zapotecas. The conjugation of a verb in this language would give school-boys more trouble than to master the intricate inflection of the Greek verbs of precious memory.

On the Improvement of the Western Rivers.

By Chas. M. Scott.

I shall offer no apology for giving my views on the subject of River Improvements, feeling that I am not an egotist in doing so, as an experience of over fifty years on the different rivers of the West has given me opportunities of forming opinions on the subject. Believing that each one should add all he can to the common stock of knowledge, I have ventured to add my mite.

The subject of River Improvements is one that should interest every man in this broad land, as it embraces in its scope the whole future of this country, not only in its commercial, but its agricultural aspect, and also its sanitary condition.

A majority of those that discuss this subject, look at it from only one point of view—commercial, agricultural, or sanitary; yet they are all intimately connected, and that which will accomplish the one in the highest degree will also accomplish all the others: that is to say, the best system to protect the lands from overflow will also produce deep permanent channels, and the draining of the swamps and rendering them fit for cultivation must destroy the malaria. The work, if done by the present system, must be done at an expense that will be more than the value of the country, unless labor is reduced to the level of China.

The time has come when we must choose between the different systems that are offered, and we should bear in mind that the future of this country rests more on the adoption of a wise system of improvements than on any other thing.

Before taking up the different systems I shall state the different factors in the problem, and shall challenge every system that does not take them into consideration as worse than useless, when applied to the lower Mississippi and lower Arkansas.

These factors are, first, fall; second, volume; third, curves; fourth, tenacity of bottom and sides.

The fall of the river is diminished as the river is lengthened by the cutting of banks, which diminishes velocity.

Volume and velocity determine the sediment-carrying, or scouring, capacity.

Curves modify velocity, and scouring is advanced or retarded by the tenacity of the sides and bottom.

These few simple factors cover the whole ground of river improvements, land reclamation, and the sanitary conditions of the Mississippi valley. I shall endeavor to point out how the different factors act, and to show their effect.

The following *data*, compiled from Humphry and Abbott's reports on the Mississippi River, will illustrate the effect of fall, volume, and curves, on velocity:

The fall of the Mississippi from St. Louis to the Gulf of Mexico is, in high water 408 feet, and in low 369. The air-line distance is about 700 miles, and by the river 1300. This gives 0.31 foot fall to the mile in high and 0.28 in low water. It is obvious to all that if this distance (1300 miles) is increased or diminished, the ratio of fall is diminished or increased in proportion.

From St. Louis to Cairo (173 miles) the fall in high water is 86 feet and in low water 100 feet (14 feet more in low water than in high).

From Cairo to Columbus (21 miles) the fall in high water is 12 feet and in low 8 feet (4 feet more in high than in low water).

From Columbus to Memphis (204 miles), 89 feet in high and 82 in low water (7 feet more in high than in low water).

From Memphis to Natchez (494 miles) the fall in high water is 155 feet and in low water 166 feet (11 feet more in low than in high water).

From Natchez to Carrollton (275 miles), 50.7 feet fall in high water and 8.1 feet in low (42.6 feet more in high water than in low).

From Carrollton to the Gulf (104 miles), 15.3 feet in high and 0.9 of a foot in low water (14.4 feet more fall in high than in low water).

An examination of the foregoing facts shows two paradoxes that are easily explained by a knowledge of the effect of volume and curves. From St. Louis to Cairo and also from Memphis to Natchez the fall is greater in low water than in high (14 feet in the first and 11 feet in the second), and, if the friction on the bottom and sides of the lesser volume, with the greater fall, did not modify it, the current would be a fraction over $\frac{1}{12}$ greater in low water than in high between St. Louis and Cairo, and over $\frac{1}{15}$ greater between Memphis and Natchez.

Now, on the other hand, the fall from Cairo to Columbus (21 miles) is 4 feet more in high than in low water (12 feet in high and 8 feet in low water). This fall of 12 feet in 21 miles of such a volume of water, if not checked by the curves of Lucas Bend and Iron Banks, would be a torrent; but owing to those two curves the current is hardly as strong as at many places where there is less fall.

Another element is the tenacity of the banks and the character of the bottom of the river. The Mississippi (from Cairo to the Gulf) and the lower Arkansas flow through an alluvial formation of an unknown depth, and this alluvium varies in tenacity as the deposits have taken place in slacker or stronger currents, those forming under or behind a bar being invariably the more tenacious, and resisting the action of the current much longer than those which have formed outside of or on top of a bar. The ooze that settles in the old "cut-offs" becomes in time stiff blue clay, that resists the action of the current where the river has cut back to the old bed, as is shown at several of the old mouths of the "cut-offs."

The banks are also affected by the clearing off of the timber growing on them.

In the early days of steamboating the banks were covered with a dense growth of timber, the fibrous roots of which bound the banks until they were undermined to a considerable distance, and when a slide took place it frequently extended back over 100 feet, and as much as 200 yards up and down the river.

These slides carried the timber growing on them, down in the same position in which it grew and carried the roots below the strong current, thus protecting the banks behind the slide for years, giving time for the filling up and growth of timber on the opposite side, thus preserving the normal width and depth.

At this time we have no accurate data in regard to the former width and depth of the river, but an approximation may be reached by knowing the low-water depths of the river at intervals of (say) 10 years, and even that can only be an approximation. In 1828 there were no steamboats on the Mississippi that drew less than 6 feet light, or 8 feet loaded; yet they found no difficulty in coming to America landing (4 miles above Cairo) during the whole year, unless stopped by ice, carrying freight and passengers sufficient to make it profitable.

In 1838 (the lowest water ever known in the lower Ohio—9 inches at Rockport, Puppy creek, and Cumberland Island) there was not less than 7 feet at Plum Point, the shallowest place below Cairo.

In 1848 the shallowest water below Cairo was 6 feet, and there were three places of that depth, viz., Plum Point, head of Island 60, and foot of Island 65.

In 1858 the shoal water had decreased to 4½ at Helena and 5 feet at Plum Point and Paw-paw, and less than 6 feet at several other places.

In 1868, 5 feet was all that could be found at Phillips', Point Pleasant, Island 21, Plum Point, Island 40, President's Island, St. Francis Island, Helena, Horseshoe cut-off, Island 69, Jersey Point, Paw-paw, and Glascox Island.

In 1878 the low water was more extensive, but hardly so shallow, except at Plum Point.

This constant decrease in depth can only be imputed to one single cause, namely, the clearing of the banks and country.

The clearing of the banks affects the river as follows: When the timber is cleared, the decaying roots become channels to convey the water into and soften the banks, and when a cave takes place it is no longer a slide, but a tumble over and breaking up of the mass, that is soon swept away by the current, and the undermining again goes on. Thus the widening goes on much faster than the filling on the opposite shore, and the shoaling or filling up of the channel follows the widening.

The clearing of the country above affects the rivers by opening the outlets of the swamps. These swamps were formerly reservoirs that held a large portion of the rain and melted snow in the spring and wet seasons, and during the dry weather they supplied a large portion of moisture to the atmosphere, and also, oozing through the soil, supplied numerous springs along the different water-courses, where now there is nothing but dry sand. Thus the clearing of the country increases the overflow in the wet season, and, aided by the widening of the river, is gradually reducing the depth in the dry season. The rapid destruction of the banks, consequent on the destruction of the timber, is still greater where the caving is at banks of recent formation, as they have no solidity, being only sand mixed with alluvium; and, as the filling is more rapid, there is more sand in the new than in the older deposits.

Having fully shown how the forces we mentioned act, I shall now proceed to analyze the different systems that have been offered, and endeavor to show their merits and defects, and I shall illustrate my criticisms by referring to other rivers where conditions similar to those found in our western rivers obtain.

The first one is the *levee system.* I shall request those that are in favor of it as anything but a temporary measure, to examine Louisiana Bend (at the northern line of Louisiana) and Lake Providence Bend, and indeed the whole river from Baton Rouge up. At the two points named, not less than three very large and expensive levees have been swept away since 1843.

An examination of the effects of caving demonstrates that it is more important to protect the banks than to build levees, as without stable banks we can have no permanent levees; and if, with the protection of the banks, the overflow can be reduced, the use of levees would be abandoned.

The building of the levees, as carried on in Italy and China, would at once destroy nearly every plantation along the river from Commerce, Mo., to the Gulf, by throwing them in front of the levees. And, whilst it would materially shorten the length, it would more than quadruple the cost, as the increase in the perpendicular height would average that at least.

According to Humphry & Abbott's report, the average slope of the banks back from the river to the swamp is 7 feet in the first mile; but a close comparison of their table with the Government map prepared by Major Charles R. Sutur, reveals the following fact, namely, that wherever the slope has been taken near the middle of a bend, where the course of the river is north and south and the slope is taken east or west, the slope is over 9 feet to the mile; but when the slope is taken near the head or foot of a bend, or towards north or south, the slope is much less, thus reducing the general average: and a fair estimate from the above data would give at least 12 feet lower for the base of the levee than the present base. It should be borne in mind that the levees of Italy and China do not follow the windings of the river, but are built back far enough from the river to allow the water to spread during floods and fill up the space between, and, instead of following the sinuosities of the river, they follow nearly straight lines. On the Po the average distance between the levees is over three miles, although occasionally much wider.

Mills gives the distance between the levees on the Hoang-Ho (or Yellow river) as averaging ten miles.

The effect of this widening of the river during floods is to cause a slackening of the current and a more rapid deposit of the sediment, gradually raising the bed until it again requires the raising of the levees.

Both the Po and the Hoang-Ho prove this, as on the former in many places they exceed 30 feet and on the latter over 100 feet in height. The inhabitants live in constant danger. Indeed, about forty years ago the Hoang-Ho broke its northern bank about 200 miles from its entrance into the Yellow Sea, and, making a new channel at an angle of about 45° with its former course, it poured its whole volume into the Gulf of Petschili, nearly 300 miles in a direct line northwest from its former mouth. In its change it destroyed over one million of human lives and hundreds of millions of dollars' worth of property. These disasters have occurred so often that they have procured for it the name of the River of Sorrow.

The Po also furnishes numerous records of disasters by the breaking of its levees. The recent disaster on the Theiss, at Szegedin, Hungary, that is arousing the sympathy of the civilized world, is a case in point.

In conclusion of this part of the subject, I would respectfully ask the advocates of the levee system to examine the arguments I offer against its being made anything but a temporary measure for present relief.

The next plan to be examined is that adopted by the Government engineers, and the different methods by which they have endeavored to carry out their plans, which may properly be called the *lengthening theory*, as Captain Eads's may be called the *concentrating theory*, Captain Cowden's the *scattering theory*, and Scott's the *shortening theory*.

The work done at French Island, Scuffletown, and Cumberland Island, on the lower Ohio, and the dams at Establishment and Devil's islands on the Mississippi, show the lengthening theory, while the work done at Cahokia Bend and Horse-tail indicate a change in their plans.

This system is well adapted to clear streams flowing over a rock bottom and having a good fall and rapid current; but when the fall is hardly sufficient to carry the sediment, it is destructive, and the more so if the bottom and sides are alluvial, as it causes a more rapid deposit of the sediment by slackening of the current, and gradually destroys the navigation it was designed to improve. By forcing the current against the alluvial banks the curves become deeper, and the diminishing velocity, together with the consequent widening, results in the formation of a shoal.

It will be of use to examine the cost of their work when completed, and, if possible, ascertain before we spend much more, whether anything can be done by the present system that will pay for the outlay.

We may take the piers of the St. Louis and Illinois bridge for the depth, and estimate from the surface of low water to bed-rock as 100 feet, premising that a dam or dyke built of broken stone (as has been used heretofore) will sink until it reaches the bed-rock, unless built above the highest floods.

This dyke must extend at least 10 feet above low water when finished, with a surface of 5 feet on top, with sides of not less than 45 degrees slope; this gives us a sectional area of 12,650 feet or 2,024,000 perches per mile, costing over one dollar per perch. It would require over thirty miles of dyke to secure the river from St. Louis to Cairo, and when we get below Cairo it is safe to double the depth and quadruple the cost. It will require but little knowledge of the public to know that such expense cannot be borne by it.

It is true that the engineer in charge (Col. Simpson) has endeavored to find a less expensive method, but the same agency that wears the solid rock below a fall will destroy any solid dyke built on the quicksands of the Mississippi unless it extends above the highest water; that agency is the reacting eddy washing out the sand below if at right angles, and above if diagonal, to the current, causing it to sink and break up in a short time.

The dyke across Alton Slough is a fair test of this kind of work in comparatively slack water and out of the main current altogether, but the test now being made in Cahokia Bend will prove whether it is adapted to the comparatively shallow water of the river above Cairo, but its efficiency may well be doubted where the water is deep.

We have no means of ascertaining the first cost of such work, but, even if much cheaper than the first method, it cannot be considered the cheapest until tested by comparison with other methods. Furthermore, the system now under trial construction can only go on during low water, and, judging of its stability by that of Alton Slough, it is doubtful if it is possible to make a work of the kind permanent in the strong currents of the Mississippi between the mouth of the Missouri and Cairo, and still more doubtful below Cairo.

The next plan proposed is that of Captain Eads, which may properly be called the concentrating theory combined with the lengthening.

Mr. Eads's plan is to narrow the wide places in order to concentrate the water and cause it to cut a deeper bed for itself.

Mr. Eads makes no provision against the lengthening of the river. He claims that the narrowing of the channel at the shoal places, and the consequent deepening, will accomplish the prevention of overflow.

In examining this plan we find that Capt. Eads does not take into account the gradual lengthening of the river consequent upon the more rapid destruction of the banks now than formerly. It is a well established fact that the length of the river from Cairo to New Orleans has sensibly increased during the last fifty years. Authorities do not agree on the actual increase, some reducing it to 20 miles, whilst others make it over 50; but all agree that there has been an increase notwithstanding there has been over 200 miles of shortening by "cut-offs," and leaving bends of islands, and going through shutes (as at Paw-paw and 95). It will be apparent to the most superficial observer, that, unless the lengthening of the river is taken into the calculation, the problem will not be solved except temporarily. This one objection reduces his system to a temporary expedient, and as such it should be considered.

The next is Captain Cowden's plan, or what may properly be considered the scattering theory.

Capt. Cowden advocates the opening of outlets, first into the Gulf, and next into the swamps; and also to divert Red river into the Calcasieu.

Capt. Cowden does not appear to know that the sediment-carrying capacity depends upon the velocity, and that the velocity depends upon the fall and volume modified by the curves, and that if the volume is reduced without increasing the fall, or reducing the curves, the velocity will be reduced, causing a more rapid deposit and destroying the navigation and increasing the malarious character of the country; in short, reducing it to the same character as the lower Danube, or the sluggish lagoons of the south. This plan can only be of the most temporary character, as the constant deposits consequent on the lessened volume, aided by the lengthening, will soon destroy the navigation, and with the destruction of navigation will also destroy the country by increasing the malarious area.

Capt. Cowden has issued several pamphlets illustrative of his views of river improvements, and, if his knowledge of what is required on the subject is to be judged by the premises he has laid down in his paper, it will show clearly that he does not comprehend the problem. He claims that the crevasse at Bonnet Quarre has lessened the rise of the river at Natchez over six feet, and on this assertion he bases his scattering theory. His claim, unless shown to be false, will certainly draw converts to his theory, and it is the duty of those that know the fallacy of his premises to show their real merit.

Capt. Cowden does not appear to know the effect of curves any better than he does the effect of volume. The change in the shape of the river at Ellis Cliffs, 20 miles below Natchez, has produced the effect that he imputes to the crevasse 235 miles below. A few years ago the river struck the bluff at an acute angle, and banked up in the same manner (but worse) that it now does at Columbus, backing the current for miles above Natchez. The point below has gradually been cut away until now the current comes in below the bluff, and has cut a wide regular bend, and allows the water a free passage, lessening the resistance to the flow of water during floods. If Capt. Cowden had known the effect of curves, he would not have been led into this error.

In the last forty years there have been four heavy crevasses from Bonnet Quarre Church down, and several between there and the mouth of Red river; but until the point at Ellis Cliffs wore away sufficiently to destroy the dam that it caused, there was no knowledge of such a grand effect as that given by Capt. Cowden.

The last is Scott's, or the shortening combined with the concentrating theory. Scott proposes to imitate Nature by using the largest timber that can be procured along the river and its tributaries, and by building artificial wrack-heaps, beginning in the slack water at the head of the bend and running them out in curves down from the bend, directing the current from the bend to the point opposite, as shown in the figure. The number of, and distance between, the wrack-heaps will be determined by local peculiarities, the object being to protect the bend from being cut away. Each wrack-heap will begin at the bank in the slack water caused by the one above, in order to prevent the current from getting behind and cutting the bank. Thus by gradually shortening the bends the whole river will be shortened, increasing its average fall and its scouring capacity, causing it to cut a deeper bed for itself, and thus gradually doing away with the necessity for levees, and permitting finally a permanent draining of the swamps.

The artificial wrack-heap is based on the natural action of the river where the banks are covered with timber, and was suggested to the writer by observations made on the wrack-heaps that have been built by the river itself, as at Island 16, Devil's Elbow, and Islands 66 and 82. At the places named wrack-heaps have been formed by the river, and they have effectually resisted the current, forcing the channel across the river and forming a bar below until the shore above was cut away, and, allowing the current to get behind them, they were gradually left on the opposite side of the river.

The wrack-heap if properly fastened is immovable, and if constructed in proper places is practically indestructible.

The difference between the wrack-heap dyke and any solid dyke, whether of stone, timber piles and willows with stone ballast, or earthen embankments, is, that it is cheaper and more permanent than any other that will allow the current during high water to flow over it. The current passing through the interstices of the branches prevents entirely the reacting eddy, which is so destructive to solid dykes of any kind that do not rest on a solid foundation. In passing through the branches, the current is retarded in its flow, and, as velocity is an important factor in carrying sediment, the retardation causes deposits below and behind the wrack-heap, and a bar is formed, which in turn reinforces and strengthens the wrack-heap. The combination of the two forces the water in a new direction.

The wrack-heap can be built at all stages of the river, except during ice; but high water is the most favorable, and spring and early summer the best time, as in high water there is most sediment, and during early summer the leaves are thicker and stronger on the trees, and would form an important factor in resisting the flow of the current.

The cost of the wrack-heap dyke would be so small in comparison with any other that has been offered, that it looks ridiculous; whilst the time required to construct them is so short, that, if at once adopted, the present generation might expect to reap some of the benefits.

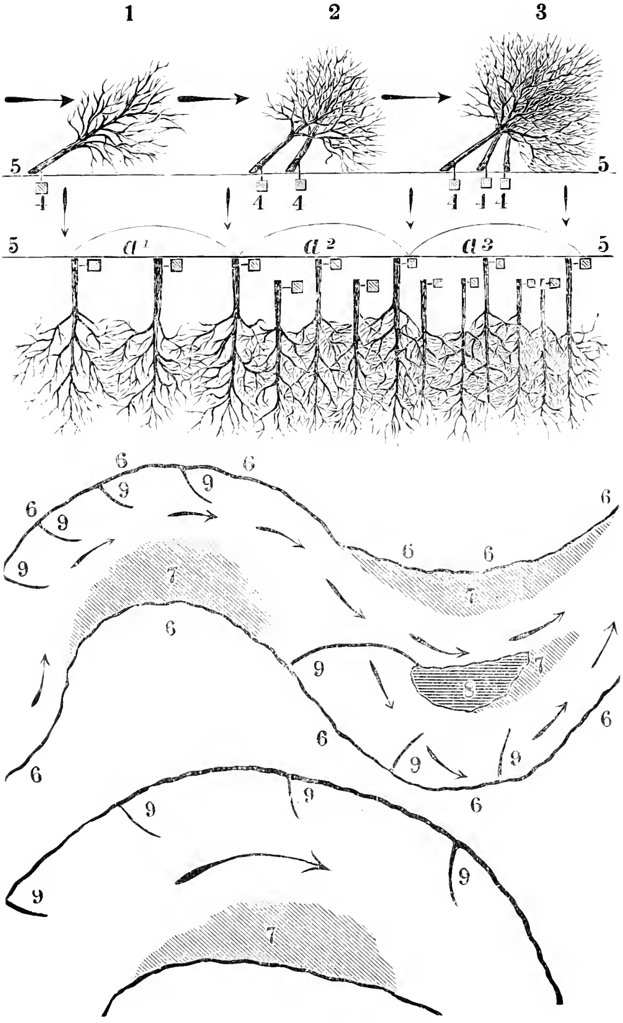
To sum up the whole argument in four propositions, we assert: *First*—That neglect of the river means the destruction of navigation, agriculture, and health. *Second*—An expensive system means no system. *Third*—A wrong system means failure. *Fourth*—A proper system means prosperity in all directions; for as the farmer is protected, the transportation of his products gives employment to commerce, and health encourages immigration.

EXPLANATION OF THE PLATE.

1. End view of single line of trees in from 6 to 20 feet depth of water.
2. End view of double line of trees in from 20 to 35 feet of water.
3. End view of triple line of trees in from 35 to 50 feet or over.
4. Rock anchors fastened to trees by iron rods connecting with bolts fastened in the tree and rock.
5. Bottom of river.
6. Banks of the river.
7. Sandbars.
8. "Tow-head" where there are two channels, causing shallow water in both.
9. Short spur dykes that protect the shore and give direction to the current.

a 1. A perpendicular view of single row of trees in dyke.
a 2. A perpendicular view of double line of trees in dyke.
a 3. A perpendicular view of triple line or more in dyke.

The arrows show the course of the current.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Egyptian Theology, according to a Paris Mummy-coffin.

By Prof. G. Seyffarth, D.D.

The question concerning the signification of the deities of all Pagan religions, especially those of the ancient Egyptians, has, during the eighteenth and nineteenth centuries, been ventilated in numberless works; the results, however, are so different that it would be impossible to answer the question decidedly had not Providence spared the aforesaid inscription.

In the first place, we have to specify the different sentiments of modern Mythologists; then we shall see what ancient authors report in reference to Egyptian and other deities, and finally the conclusive contents of our mummy-coffin may be brought to light.

The oldest theory for explaining the nature of heathen gods is termed fetishism. Its author presumed that the ancient gentiles, not very different from brutes, worshipped, as the Hottentots are still doing, vile objects of nature, because the latter were believed to be invested with magic powers, either propitious or unpropitious to the living. Hence the opinion originated that the Egyptians took their sacred animals — e.g. Apis, Mnevis, Onuphis, crocodiles, cats, ibises, hawks, serpents — and other beasts, of which mummies have been found in the catacombs, for their deities.

The adherents of natural philosophy guessed the pagan gods to have represented in general different physical objects, e.g. the starry heavens, the earth, air, tempests, winds, fire, water, rivers, fountains, rain, lakes, ponds, woods, trees, day, night, lightning, and the like; to which Prof. Movers of Breslau added the unparalleled deities, Lingam, Phallus, and Pudendum muliebre.

According to the chemical principle the ancient deities were chemical potencies, and hence, e.g., Peleus signified alkali, and Thetis was an acid.

The historians brought out that the ancient gods must have been meritorious men of old, and even that the same were personified periods of different times: hence Saturn was the first "world-period."

In reference to the political theory, it was taught that the ancient divinities were mere fictions of ancient kings for the purpose of terrifying their subjects, and to keep them in humble submission.

By means of the moral hypothesis it was stated that the ancient gods were representatives of human virtues—e.g. bravery, jovialty, honesty, faithfulness, loyalty—being exposed in the temples for the purpose of inciting the spectator how to act during his lifetime.

O. Mueller fancied the Greeks and Romans to have adored the geographical objects of Greece and Italy, e.g. Mt. Ætna, Olympus, the Mediterranean sea, the fields, medical plants, and the like. Hence the Egyptian divinities would have been similar things.

According to the astronomical basis the ancient gods were the constellations and principal stars of the heavens, e.g. the dog-star, Orion, Perseus, Andromeda, and so on.

The philosophers guessed the ancient deities to have represented metaphysical conceptions, as sanctity, justice, power, and the like.

All these statements stand in direct opposition with the testimony of ancient authors, as we shall now see. In advance, it is to be borne in mind that all traditions concur in putting beyond question that all pagan religions originated from one fountain, viz. from the idolatry of the Babylonians, prior to the dispersion of the nations in 2780 B.C. (See the author's "Berichtigungen der alten Geschichte," etc., p. 203.) First, in Jeremiah (li. 7) we read: "Babylon had been a golden cup in the Lord's hand, that made all the earth drunken: the nations have drunken of her wine; therefore the nations are mad."—The Georgian Chronicle (Journal Asiat., Paris, Dec. 1833, p. 535) reports that soon after the dispersion of the nations, the latter forgot their Creator, whereupon they worshipped the planets.—Plutarch (Is. 377) and Lutatius (Theb. iv. 316) report as follows: "The deities of the Greeks and barbarians, both in the northern and southern regions, are the same."—Cicero (N. D. i. 30): "Quot hominum linguæ," he says, "tot nomina deorum."—The Greeks and Romans constantly paralleled their deities with those of Egypt, Gallia, Germania, and the Orient.—Jeremiah (viii. 2) prophesies that "the pagans will spread (the bones of the prophets) before the sun, and the moon, and all the hosts of heaven, whom they have loved, and whom they have served, and after whom they have walked, and whom they have sought, and whom they have worshipped."—Herodotus narrates that the twelve great gods originated from the planetary gods about 17,000 years (i.e. notoriously months—Procl. Plat. Tim. i. 31; Lactant. Inst. ii. 131; Diodor. i. 26; Plin. H. N. vii. 49; Plut. Numa, 18; Horapollo, etc.) previous to Amos (600 B.C.), consequently about 2017 years B.C. (Comp. my "Grundsätze der Mythologie," etc., Leip. 1834, p. 21.) Since, then, all pagan religions originated from the same source, and were of the same nature, we have the privilege to determine the significations of the Egyptian deities by the help of Greek and Roman ones. The latter were, as is well known, the seven planets—Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon—being visible with the naked eye; and, consequently, an Egyptian god, compared by ancient authors with one of the Roman and Greek planetary gods, must of necessity represent the same planetary god.

This result is confirmed by many explicit enunciations of old. For Aristotle (Met. xi. 8, p. 207) testifies: "It is reported by the ancients, or rather by the very ancients, that the deities were the planets and the constellations."—The Egyptian priest Chæremon (Jambl. Myst. Æg. 7) asserts: "Ægyptii non alios ponunt deos præter vulgo dictos planetas atque Zodiaci signa."—Tacitus (H. iv. 5): "Saturni stella," says he, "e septem sideribus, quis mortales reguntur, præcipua potestate."—Herodotus and Diodorus and Plutarch in many places testify that the Egyptian deities were the seven Cabiri, i.e. according to the Hebrew כביר (kebir, potens), the seven planets, and next to them the twelve signs of the Zodiac.—Porphyrius (Abst. iv. § 9) informs us that the sacred animals of the Egyptian symbolized *Dei in res omnes potentiam, quam singuli deorum declarant.* This passage is illustrated by Clement of Alexandria (Protr. p. 14), who says: "Septem sunt dii planetæ, octavus (shmun, the earth), qui ex his omnibus constat, mundus." To-wit, the ancient astronomers report that all, both invisible and visible, objects were distributed to the seven planets in that way that each planet received all things being similar to his true or imaginary nature, and hence the objects referred to a certain planet were termed the "ducatus" of the same planet.

(See the author's Astronomia Æg. vol. ii., and Grundsätze der Mythologie, p. 143.)

From these and many similar testimonials we learn that the sacred animals of the Egyptians were not at all their deities, but emblems of their great gods; moreover, that the Egyptians, besides their planetary and zodiacal divinities, worshipped the Creator of all that exists.

There is no doubt that the aforesaid ancient authors intended to report the truth; since, however, ancient authors as well as modern ones are liable to err, the question is whether the aforesaid evidences are confirmed by the autografic inscriptions under consideration, or not. The original colored copy of the Paris Mummy-coffin will be found in my Bibliotheca Ægyptiaca MS. vol. 6, No. 6279. Let us see.

Plate I. is the copy of a photograph, reduced to smaller size; the colors are, of course, changed; the outlines, however, are all correct, except the two cats' heads within the black semi-disks, which are too much blacked, and therefore not very clear. The whole represents three different classes of Egyptian deities, viz.: the twelve figures in the middle of the tablet, the signs of the Zodiac; then the seven Cabiri on each side, the Planets; finally, the black beetle, and the human figures above the black semi-disks, which, as well as the ram-headed vulture, signify the Creator. All these figures are accompanied with hieroglyphic legends, which are to be deciphered grammatically. We keep the order of the ciphers on Plate II.

Nos. 1 & 2. On the left side of the picture (Pl. I.) seven ram-headed deities are to be seen, which represent the seven planets, the Egyptian Cabiri. For the name of the ram was ⲁⲓⲗ. the Hebrew איל (*ail*); consequently the man (ϩⲁⲙ) with the head of a ram expresses syllabically the word *ham-ail*, the man of power, the mighty one; since איל (*el*) signifies fortis, mighty, it is the synonym of כביר (kabir). fortis, magnus. Accordingly the seven *Ham-el* are other names for Cabiri, the Egyptian planets, otherwise called Dii potes, Δυνάμεις, Theraphim, Patæci, and the like. Moreover, by the same ram-headed figure, the tablet—found in the so-called Isis temple of Pompei—signifies the mighty or almighty God, whom the subjoined cartouche calls *Kennufi*, i.e. the good Creator, termed "El," "Eloah," the Arabic "Allah."

The אלילים (elilim), so often mentioned in the Old Testament, i.e. the little powers, refer likewise to the minor pagan deities of the planets.

3. The foolish idea of the Champollionists that the beetle signifies *cheper*, a word not to be found in any language, needs no refutation. This scarabæus expresses *t* in many proper names, and its appellation was *κάνθαρος*, i.e. ⲕⲛⲛ-ϩⲧⲟⲣ, the Hebrew אדיר (Adir), the divine Creator. Hence our group signifies *tr*, i.e. ⲑⲣⲉ facere, or ϩⲧⲟⲣ god.

4. It is astonishing indeed that the Champollionists, during a period of fifty-four years, did not learn what the papyrus scroll signifies. Its name being ϫⲱⲙ (see my Gram. Æg. p. 94, No. 492), this scroll expresses plurality, the letters *km*, the Coptic ϫⲟⲙ, copia, multitude. Hence it is evident that the Hebrew ים (yim), is the same, but the softened ϫⲟⲙ, plurality. For it is known that *k* very often goes over into the consonant *y*, e.g. in ϫⲫⲟⲧⲓ (gignere), the Hebrew ילד (yalat), gignere. Comp. ידע (yada), scire, with ⲕⲁⲧⲓ (scire, intelligere); ים (yam) with ϫⲟⲙ (lebes, *φιάλα*, lacus); ⲕⲟⲓ with ⲓⲟϩⲓ (ager), and so forth. Hence, by the way, it is erroneous what Gesenius, in his Lexicon, asserts, that the molten sea was "hyperbolice" called a sea, for ים (yam) as well as ϫⲟⲙ denotes a kettle, אגם; hence a lake, especially the Mediterranean sea or lake.—This same papyrus scroll moreover, expresses plurality in eight other places of our inscription (Nos. 13, 15, 20, 26, 30, 41, 44, 55). The Champollionist Brugsch, not knowing what to do with this papyrus scroll, declared its picture to be a mere "expletive sign," destitute of any phonetic or ideologic value. Hence it came to pass that Brugsch's great Dictionary of four volumes in quarto, containing nearly ten thousand words, changed some thousands of substantives into verbs, and plurals into singulars. The same work, moreover, did not originate from translating entire Egyptian texts, but from single groups severed from the context, of which the significations were defined by guessing and by means of determinatives taken ideologically. Hence it is natural that this voluminous Dictionary contains in every hundred words ninety-nine wrong ones; and I do not understand how a prudent man ventured to appear before the scientific world with such a fabrication prior to having learned the Egyptian alphabet, the grammatical forms, the Cop-

tic language, and the art of deciphering grammatically entire Egyptian inscriptions. Sapienti sat!—The papyrus scroll is followed by three boundary stones, referring to the root ⲟⲩⲱϯ, the Hebrew בד (bad), dividere, by which stones the word ⲟⲩⲉⲧ, alius, was expressed. (See Nos. 6, 7, 11, 13, 61 *d*.) Hence the scroll with the boundary stones simply expresses plurality, but emphatically.

5. The acre, very often intersected with furrows (see Pl. II. 60 *b*.), called ⲥⲣⲉ, related with the Hebrew אכר (akar, arare), the Latin *ager*, Gr. ἀγρός, Goth. *akr*, Germ. *Acker*, our "acre," expresses syllabically *kr*, alphabetically *k*, because it stands very often for *kr* (Pl. II. No. 60, *b*). Hence this figure signifies *kr* very often, e.g. in *Græ-cus* on the Tanis-stone. Brugsch, not knowing the name of the "acre," takes this figure always for *s*, and hence his Dictionary spells and translates some thousands of groups wrongly. The following figure of thrashed straw (ⲧⲟϩ, ⲧⲟϩ) forms with the preceding *k* the word ⲕⲟⲧ, the Hebrew אכד (akad), circumire, revolution. The same (No. 7) is expressed by the well known letters *kt*. Hence our groups clearly express "planeta," "revolving star," by "makers of revolutions." The Champollionists explain the same figure ideologically by "country" and "loaf."

6. The well known axe (ⲁⲟⲏⲣ, ϩⲁⲧⲏⲣ), which in numberless places signifies אדיר (adir), mighty, deity, alphabetically *h*, Brugsch took for *n*, and for the abbreviated word *nuter*, god; but, alas! no such word exists in any ancient language.

7. This substantive with the plural termination settles the point that No. 5 is to be spelled *kt*, and not *so*; for the well known ansated dish expresses constantly *k*, and the walking feet (ⲧⲟⲟⲩⲉ) express *t* and *tt*, e.g. in Athothis (Gram. Æg. p. 56 & 78, No. 363). Brugsch imagined the feet to signify *i*. The preceding door-bar (ⲥⲃⲉ) expresses *sb*, *sp* (Gram. Æg. p. 87, No. 434), consequently ϣⲱⲡ, the German "schaffen"; but, according to the Champollionists, this figure makes intransitives, which would give downright nonsense.

8. The star, כוכב (kokab), which belongs to the root כבב (kobab), כאב (kaab), כבכב (kabkab), globulus, is the original word for the Coptic ⲥⲓⲟⲩ (*siv*). Hence the Champollionists erroneously spell the star *s* instead of *kb*, acrophonically *k*. The following

letters *tp*, expressed by the notorious mount (*t*) and the yard (ϩⲏⲛⲓ, the German *Hof*), furnish the word ⲑⲉⲃⲓ, תבה (thebah) caverna, cella, arca. The whole group, therefore, means "the cave of the starred heaven within which the planets revolve." Champollion imagined the yard to express *h*, instead of *hp* and *p*.

9. The sparrow-hawk being in numberless places rendered by the well known letters *kr* (Pl. II. 59 *b*.), it signifies *kr*, and not, as Brugsch fancied, *Horus*. Hence the man ornamented with the head of a sparrow-hawk, *hm kr*, i.e. ϩⲁⲙ ϫⲟⲣ, signifies "the mighty one," "potens"; consequently the same which the ram-headed figure (No. 1) represents, viz. כביר (cabir), a planetary god.

11, 12. The star, called כוכב (kokab), the Arabic כב (kob), "globulus," corruptly ⲥⲓⲟⲩ (sib), gives syllabically *kb*, "stella"; plurally, "the stars"; with the following *kt* (No. 5), "the revolving stars," i.e. the planets, ⲕⲟⲧ, circumire.

13 signifies by three suffixes the word "plurality," and this is a very common usage of the Egyptians (see Todtenbuch 101, titel 15, 17, 32, 70, 75), to-wit: the pullet ⲁⲛⲱⲓ, the corrupted ϩⲁⲛⲱⲧⲓ, the Greek ὕπταμαι, signifies the letters *hpt*, e.g. in ϩⲟⲛⲧ, creare; ϩⲟⲛⲧ ϩⲁⲙ, the Creator (No. 52), as we shall see hereafter; and hence it expresses the Hebrew ות (hoth), plurality. The Hebrew ו, by the way, is not, as Gesenius imagined, a hook for fastening tents, for such trifles would never have been received into a sacred alphabet; it is rather the eared snake (cerastes), called ϩⲟϥ, represented very often as standing. Hence this ות (hoth) is simply the Coptic ⲟⲩⲁⲧⲁ, multitudo, signifying plurality, e.g. in Nos. 61, *d.*; 59, *c.*; 62, *c.* The very same plural termination ות (hoth) we find expressed by the clew (No. 13, *b.*) even in the same words, because the clew was termed ϩⲟⲛⲧ, compingere, convolvere. Moreover, it is an inveterated error that ות (hoth) is the plural termination of feminines; for numerous words, being masculine, have the plural suffix ות, and many feminines have ים instead of ות, e.g. אב (ab), father; אבות (abhoth), fathers; נשים (nashim), wives. Besides, very many substantives are plurally terminated with both ים and ות. In short, our group (No. 13) adopted three different plural suffixes, ⲟⲩⲁⲧⲁ, ϫⲟⲙ, and ⲟⲩⲟⲧ, whilst one would have been sufficient. (Comp. No. 13

with Nos. 5, 15, 19, 26, 55, 59 *c.*, 62 *c.* & *f.*)—Is it not strange in the extreme that the Champollionists during a period of fifty-four years did not notice these signs of plurality; that they took the pullet and the clew for *o* instead of *hpt?* They are, however, excusable, because the "great master" knew not at all the key to the Egyptian literature, viz., the rule that each of the 630 hieroglyphs regularly signifies the consonants contained in the name of the figure. Hence it happens that Brugsch's great Dictionary enumerates some thousands of words which were substantives and not verbs, moreover singulars instead of plurals.

14. Above the heads of the seven Cabiri the following legend is placed: *axe* and *man*—signifying the men of power. For the axe (ϩⲁⲧⲏⲣ, ⲁⲑⲉⲣ, ⲧⲱⲣⲓ) alone furnished אדיר (adir) mighty, but the added figure of a man (ϩⲁⲙ, the Latin *homo*) gives "the man of power." (Comp. Nos. 25, 31, 39, 52, 59 *e.f.*, 60 *e.*) Champollion and his successors imagined this human figure to represent ideologically a god.

15. The handle of a knife or fan, the Coptic and Hebrew ענד (anat), manubrium, expresses the letters *ant* and *nt*; accordingly, ⲛⲟⲩⲧⲉ, deity; alphabetically, *n*: and hence we have the word ⲛⲁⲁ, magnus, plurally. (See Gram. Æg. p. 116, No. 606.)

16. Expresses *kt*, "revolving," as we have seen—Nos. 5, 12, 27, 41.

17. *n kbh*, ⲛ ⲕⲏⲡⲉ, in the vault, because the star (*kb*) furnishes the word ⲕⲏⲡⲉ, fornix, arcus; the Hebrew גב, כף (gab, kap), the vault; קבה (kubah), tentorium cameratum, related with *cavus* and ⲕⲩⲏⲛ.

18. The starred cave, as we have seen in the premises (No. 8). The same word returns in Nos. 28 and 43.

19. The figure with uplifted arms belongs to the root ϫⲓⲥⲉ, elevare, which is confirmed by the fact that it is replaced by the letters *ks* (Gram. Æg. p. 38, Nos. 47, 48, 49). It is, moreover, a substantive owing to its plural termination ים, ϫⲟⲙ, multitude.

20. The eared snake (ϩⲟϥ, ϩⲟϥ, ὄφις) involves the word ϩⲱϥ, creator; the Hebrew חוה, חיה (hivah, hijah), vivificavit, creavit. (See Nos. 30, 44, 47.)

21. The sun, being called גור (gur), the corrupted ϩⲣⲁ, ⲣⲁ, represents the words ⲟⲩⲣⲱ, ⲕⲟⲩⲣⲱ, κύριος, herus, Herr. Hence

the word פרעה (paraoh) is not the Coptic ⲟⲩⲣⲱ with the article ⲡ, as Gesenius imagined, but the Hebrew פרע (pera), princeps.

22, *m kll*, i.e. ⲙ ⲕⲗⲟⲟⲗⲉ, ϩⲗⲟⲗ, nebula, obscuritas. Hence the planets are said to be "the celebrators of the Creator, the Lord in darkness," i.e. the invisible Lord. According to the Champollionists, the solar disk always denotes the sun mimetically, and then the nonsense comes out that the sun created both the planets and itself. Query: how could the sun be called invisible, and how could it create the planets and itself?

23. The figure of a rope, or rather of the traces for attaching horses, the Hebrew יתר (yether, properly ither), expresses the letters *tr* (ⲧⲣⲉ, ⲧⲣⲟ, ⲑⲣⲉ—facere, creare), consequently the creator. The very same "traces" represent *tr* in many places, e.g. in the name Cyprus (כפתור, Captor), as the Tanis-stone demonstrates. Lepsius, in consequence of Champollion's "Key to the Egyptian Literature," not knowing that regularly each of the 630 hieroglyphs signifies the two or three consonants contained in the name of the figure, spells the group, signifying Cyprus, *kptr*. which he translates "Phœnicia," and out of the letters *binikah* (Phœnicia) he conjures Cyprus. Is that not wondrous? — The appended eared snake is the Coptic suffix ⲉϥ, suum, the Hebrew הו (*hf*). The whole passage then translates thus: (the seven planets) "the great gods revolving within the vault of the starry cave, the praisers of the architect, the invisible Lord, their creator."

24. We come now to the second class of Egyptian deities, those of the Zodiac, the twelve houses of the seven planets, represented in the midst of our monument. Diodor (ii. 30) says expressly that the *κύριοι θεοί* were twelve, of whom each superintends a sign of the Zodiac and a month of the year. Further, Chæremon, an Egyptian priest (Jamblich. Myst. Æg., Præf. p. 7) testifies: "Ægyptii non alios ponunt deos, præter vulgo dictos planetas et zodiaci signa." In Jeremiah x. 2, we read: "Learn not the way of the heathen, and be not dismayed at the signs of the heavens; for the heathen are dismayed at them." Sanchanjathon calls the signs of the Zodiac *ὄψεις θεῶν*, alias termed *πρόσωπα*, because they represented the powers of the planets, their presidents, *Οἰκοδεσπόται*.

On each side of our theological monument six figures (No. 24) appear, of which two are represented with four arms. The house of the sun (Virgo) is expressed by the solar disk with a child, and the latter, called ϣηρι, ancient ϭηρι, like the Hebrew גור (gur), infans lactans, signifies the letters *gr*, the Coptic ϭοιλε, the Hebrew גור · זור (gur), mansio, domicilium. To the same root is, as I believe, to be referred מגלות · מגרות (magaloth, magaroth), which, as is well known, are the names of the signs of the Zodiac, corresponding with the Arabian signs of the Zodiac "*mangal*" and the Coptic ⲙⲁ-ϭⲱιλι, locus habitationis. The root of these names is, no doubt, גל or גר (gol, gor), related with מצור (maqhor), turris. The house of the moon (Leo) is shown by the picture of a disk, opposite to the sun, which is, apart from a very light green ring, colorless, like the moon.

25–35 have been discussed in the premises Nos. 14–30. The only difference is that ⲟⲣⲉ, creare (No. 34), is expressed by the letters *tk*, i.e. ⲧⲱϭ, plantare, whereby the syllabic value of the traces, viz. *tr*, is put beyond question; for "plantare" and "creare" are synonyms.

36. This ligature denotes "mansion"; for the so-called "crux ansata" properly represents the human brain, viz. ⲟⲛⲭ, very often expressed by the letters *onk* (Pl. II. No. 61), which point us to the word ⲟⲛϩ, habitare, dwelling. The arm ⲙⲁϩι, the Hebrew אמה (amah), gives ⲙⲁ, locus; and hence our ligature presents the notion, "dwelling-place."

37 is the notorious sign of the genitive, ⲛⲧⲉ, τοῦ, of.

38 is not, as the Champollionists imagined, the sun, but, as we have seen (Nos. 21, 31), the word (ⲕ)ⲟⲩⲣⲟ, Κύριος, the Lord, expressed by the letters *kr*. The dish is, according to Champollion, *n*, and then an abbreviation of the word ⲛⲏⲃ (dominus), even of ⲛⲓⲙ (omnis), instead of ⲛⲓⲃⲉⲛ (omnis). That ⲛⲓⲙ, and ⲛⲏⲃ, and ⲛⲓⲃⲉⲛ, are very different vocables, makes no difference in the eyes of the Champollionists. But, alas! the name of the dish was not *neb*, but ϭλ (gal), scutum, ϫⲉλ-ⲙⲁⲉι, φιάλη, dish, גל (gol), גלה (gulah), צלח (qhalach); and hence the Tanis-stone (L. 37) expresses by the same figure *kr*, i.e. χώρα (the Heb. כלל, כר־כר, kir-kir), which the demotic text renders by the snake ⲁⲕⲟⲣι, i.e. by *kr*. (See Pl. II. No. 62, *a*. *b*.) Lepsius's explanation of the dish on the Tanis-stone is too evident to be refuted.

The same figure, moreover, expresses *kl kr* in Takelophis, Nephercheres, ⲕⲁⲗⲉⲓⲗ, and so on. Hence the dish signifies syllabically *kl*, i.e. ϫⲟⲗ, כל (kol), the universe, and the whole passage reads as follows: "The Creator in the dwelling of the Lord of the universe.

So far as the sparrow-hawks with human heads (Nos. 48, 49), collocated between the figures of the twelve zodiacal gods, are concerned, they represent the souls of the defunct residing in the stellar heavens, viz. the Manes. This is suggested by Horapollo (i. 7) and by the names of the involved hieroglyphs; for the sparrow-hawk expresses, as we have seen so often (Pl. II. 59, *a. b.*) *kr*, and hence *κῆρ*, cor, the soul. The head ϩⲱⲟⲩⲓⲧ, Germ. Haupt, Lat. caput, is the Hebrew כבוד (kabod), cor, anima. This is confirmed by the vignette in the Todtenbuch, p. 33, where the soul, represented by the same image, going out of the corpse, flies to the heavens. The papyrus stalk (ϫⲟⲙ, גמא, goma) refers to the heavenly garden (ϭⲱⲙ, hortus) inherited by the soul of a deceased person, being similar to the Elysian fields. The heavenly farms of the defunct are represented on all funeral papyri, e.g. in the Todtenbuch, Pl. XLI. A new copy of the sacred records of the Egyptians, discovered, three years ago, in a catacomb near Thebes, written for the queen, the wife of Pharaoh Horus, 1780 B.C., which is at present 3600 years old, represents the late queen as occupied on her farm with plowing, sowing, reaping, etc. etc. This papyrus, of which photographs were sent to the Smithsonian Institution and thence to me, is the oldest now known copy of the sacred Egyptian books, and is deposited at present in the national Museum of Paris, having cost the large sum of $1600.

However, the question will be asked: how is it that the souls of mortals were ranked with the immortal deities? The answer is, that, according to a general opinion of the ancients, the souls of the pious departed were united with the gods. Thus the Divi of the Romans were the deified souls of the defunct. The very same were the Manes and the *Μάκαρες*, the latter signifying both the deities and the souls of the beatified, as we learn from Homer and other ancient authors. *Μακάριος*, *μακαρίτης*, is notoriously the soul united with the heavenly gods, and therefore even sacrifices were offered to the former. The funeral monuments of the Greeks had regularly placed after the name of a deified person the words *μακάριος*, *μακαρίτης*. The very same practice was observed in Egypt; for all its funeral monuments join to the name of a defunct person the group No. 59 *c*., signifying the beatified Manes. For the step, invariably placed below Osiris's throne, was called ⲙⲟⲕⲓ· and hence it expresses the word מג (mag), the Greek *μέγας*, the Latin *magis*, *magnus*. The very same consonants are expressed by the figure of the sickle, the Hebrew מגל (magal), the Coptic ⲙⲁϫⲟⲩⲗ, related with *μάχαιρα* and *mucro*. This pronunciation. totally unknown to the Champollionists, is confirmed by Herodotus, who renders the same group by *Μικερῖνος*. For this is the name of the king who constructed the third great pyramid near Memphis, whose name and reigning years are very often mentioned on the monuments. Hence it comes to light that Micerinus belonged to Manetho's twentieth dynasty, and that the said pyramids were not built, as faulty Lepsius fancied, during the second dynasty, viz. before the deluge, which extended over but "a small portion of our globe," but in David's and Solomon's days.

The following hieroglyph represents a lancet, called after the aforesaid roots *mucro*, which gives again *μακάριος*, or rather, owing to its plural termination, *μακάριοι*. Hence the whole of the group signifies the Manes among the Manis. The Champollionists guessed this group to signify "justified," which is in direct opposition with the names of the respective hieroglyphs.

Add to this that all funeral *steles* and *papyri* mention the tutelar god with whom the soul of the defunct was united in heaven. All such funeral monuments commence with the words ⲕⲟⲧ ϩⲟⲩⲧ (No. 60, *c. d.*); i.e. "he (or she) went to join the god N.N." A number of funeral steles examined by me named the following deities: "All gods" (No. 61, *d.*); "the sun, the lord of both countries" (61, *c.*); "the house of the sun" (62, *d.*); "Manetho," the nourisher of all (62, *c.*); "Mah ham," the resplendent moon (59, *f.*); "*kb*," Saturn (59, *e.*); "Amun kere," the refulgent Jupiter (60, *f.*); "Hosr ham," Osiris (60, *e.*); "Ptah skr" (זכר), Mars generator (61, *f.*); "Neith mate," the mighty Neith (61, *c.*); "Teb mere," Venus genitrix (62, *f.*); "Anubis," Mercury (62, *e.*), etc. Hence it is evident that the human-headed kawks signified the souls of the dead united with the deities of the Zodiac.

We come finally to another god of the Egyptians, differently represented on our theological monument. In the midst of the twelve zodiacal deities, we notice the figure of a black beetle moving a globe, and ornamented with the head of a ram (No. 58). The latter, called *ail*, as we have seen (No. 1), expresses the Hebrew אל (El), the Arabic *Allah* (the mighty one), God. Therefore the group personates the Almighty rolling the globe of the heavens, the universe. For, in the first place, innumerable ancient authors bear witness that the Egyptians and all other ancient nations worshipped not only the seven Cabiri and the twelve great gods, but also the Creator of the planets and the signs, which is proved by many testimonials, as follows:

Sanchojathon (p. 37) reports that the Phœnicians taught Siduc (צדיק, Kadiq, the holy) to be the progenitor of the Cabiri, the planets. According to the Persians, a great king governed the world by the instrumentality of seven ministers, the planetary divinities. Porphyrius (Abst. iv. § 9) reports that the Egyptians had in their temples different animals, because they revealed "Dei in res omnes potentiam." Plutarch (Is. 377) says that the Egyptian deities signified "the universal God, but in different ways," and he declares that this nation "was in possession of the highest and purest ideas concerning the Creator of all that exists." The Greeks repeatedly mention "the father both of the men and the deities." The same God the Romans called "Deus Optimus, Maximus, mens divina," etc. The very same God was the Indian "Parabrama, unrepresented by images"; the "Allvatur" of the northern nations; the Chinese "Changti" and "Hooang-changti," i.e. the highest governor: the Thibetan "Concion"; the Sicilian statue with seven fingers; the Scandinavian god holding seven swords. Jablonskii Panthon (Prol. lviii.) cites a passage where the same god says: "Ego sum Lyra" (containing seven strings, the seven planets). The ancient Arabians believed that God's throne stands above the spheres of the planets, encompassed by a serpent (the Zodiac), as Fleischer's Catal. MSS. pp. 506, 530, bears testimony.

Moreover, the monuments themselves put out of question that the highest god of the Egyptians was the Creator of the world; for the sacred records (see my Summary of Rec. Disc. 1857, p. 63) pronounce as follows: "I am the God of the gods, the exalted

Maker of the planets and of the heavenly hosts, which are praising me above thy head." The same hymn, p. 67, says: "Look ye up to the mansions of the hosts of the mighty (planetary gods), who work for their Master, for my glory: look up to me who have established my kingdom above the heavens." A French papyrus, as will be seen on another occasion, testifies that the same god "rules the deities and the heavenly firmament"; that he "built all the inhabitants of Egypt and the oases"; that he "governs the beatified Manes"; that he "wove both the visible and invisible objects in the world," and the like. All enunciations of this character do not concern any of the planets or zodiacal gods; they refer apparently to the invisible Builder of the universe expressed by our beetle.

The question, however, will be raised, why the wise Egyptians took so despicable an insect, as a little black manure-eating beetle is, for an emblem of the almighty and infinite God? It is Herodotus who, 2378 years ago, was greatly astonished in observing the sagacity of this sacred Egyptian creature—which, by the way, is not to be found in Europe, but is quite common in America. I myself confess that, when beholding the work of this scarabæus first, I could not part from the spectacle for many hours. This little May-bug, as black as coal, scarcely as large as the nail of a human thumb, forms, together with his consort, a ball out of cow-dung, five or six times larger than the workman. This globe, as smooth as an ivory ball, contains the posterity of the pair, and, the first work being done, the problem is to save the progeny during the winter. Hence Mr. May-bug proceeds to push the ball with all the forces given to him, whilst Mrs. May-bug poises herself upon the top of the globe for the purpose of counterbalancing and propelling it. Thus the ball is rolled over plains and hills, which, with respect to the short feet of our little friends, are, in comparison, sometimes as high as the Rocky Mountains. But it occasionally happens that the colossal sphere, notwithanding all precautions, slips down into the valley. Alas! the work of a whole day or two is lost: what is to be done? Mr. and Mrs. May-bug run down as quickly as possibly and recommence their toil, in spite of hunger and thirst, no refreshment being at hand, till they finally reach a place where grass or roots do not prevent the digging, by means of their hereditary shovels, a hole, wherein the inmates of the globe are interred for a vernal resurrection.—The singular nature of this beetle is the reason that the Egyptians made it an emblem of that Being who rolls, before the eyes of all, the immense globe of the starred heavens round its axis every day.

There are, finally, two other images, representing the Creator, to be explained. The figures above the heads of the seven planets (Pl. II. No. 50) are called "the invisible Creator," because the cave—ϩⲱⲛ. ϩⲏⲙ, the Hebrew חבה (chaba)—signifies ϩⲱⲃ, Creator; and the cat's head—i.e. the cat (pars pro toto, Gram. Æg. p. 14, No. 36), called חתול (chatul), Germ. Kater—furnishes the words כדר · קדר (kadar), niger, related with "ater," hence obscurus, invisibilis. To the same root the name Ἄθωρ, called "Venus tenebrosa" (Jablons. Panth. L. i. p. 6), even "tenebræ" and "nox" (Hesych.) is to be referred. This image of the invisible Creator stands above the heads of the planets, and appears, like the beetle, in the attitude of pushing—to the end, remember, that it is the invisible God who rolls the planets amidst the fixed stars.

The same supreme deity of the Egyptians is further symbolized by the figure below the heavenly deities. For the ram's head signifies, as we have seen (Nos. 1, 58), אל (El), Allah, the Almighty, the same god which the Pompeian altar ornaments with a ram's head and calls *Κένουφι*, the good progenitor. The vulture bearing the ram's head, called *mut*, and very often expressing the letters *mt* (Gram. Æg. p. 66), furnishes the word *El*, ⲙⲁⲧⲉ, the almighty God. The spread-wings of the vulture, called ⲧⲉⲛϩⲟ, involve the word ⲧⲁⲛϩⲟ, vivificator. The ring (ⲁⲗⲟⲕ, ϩⲟⲗⲕ) in the claws of the vulture gives ϩⲟⲗⲕ, weaver, complicator. The uræus snake (ⲁⲕⲟⲣⲓ), crowned with the solar disk (ⲕⲟⲩⲣⲟ), expresses ⲕⲟⲩⲣⲟ, *κύριος*, ϫⲟⲣ, the great king. These four predicates of the supreme deity are followed by four human figures, forming, as we have seen (Nos. 14, 25, 31, 39), personal substantives, because the axe, e.g., not being followed by the man (ϩⲁⲙ), would signify "strong" or "to strengthen," and not "a strong being." The wings alone signify "vivificare," but, being followed by a human figure, give "vivifier."

This description of the highest deity is, moreover, confirmed by the added legends (No. 52), ϩⲁⲙ ϩⲟⲛⲧ, Creator, and (Nos. 53–55) ⲛⲟⲩⲣⲟ ϩⲁⲙ ϩⲧⲟⲣ ⲛⲁⲁ ϫⲟⲙ, the Lord of the great gods. For the pullet (ϩⲁⲛⲟⲧⲓ) furnishes ϩⲟⲛⲧ, concinnare, and, being followed by a man, concinnator. According to the Champollionists, the pullet is *o*, and the man symbolizes a god; and then the nonsense comes out that the Almighty was the god of the letter *o*. Allah is great! is he not?—The Champollionists take the other legend for *rer nuter god*, which is again downright nonsense, instead of "the Lord God of the great gods."

The results of the present investigation are, in short, the following:

1. The Egyptian deities were, first, the almighty Creator and Governor of the world; next to him, the seven planets and the twelve zodiacal gods: nothing else. In the midst of the latter the deified souls, the Manes, resided.

2. The sacred animals, belonging to the ducatus of a god, signified the true or imaginary virtues of the latter.

3. The Polytheistic religion of the Egyptians and all other ancient nations originated in Babylon, prior to the dispersion of the nations in 2780 B.C.

4. The language (the "sacred dialect") of the ancient Egyptians was not the modern but the ancient Coptic, related with the Hebrew and kindred dialects. (See the author's "Rudimenta," etc., L. 1826, p. 4, n. 7, and p. 13; "Unumstösslicher Beweiss," etc., L. 1840, p. 14.) Innumerable groups and grammatical forms were Hebrew roots.

5. The Egyptian literature originated from the primitive (Noachian) alphabet, and not from any idéologic writing. (Rud. hieroglyph. etc., L. 1826, p. 15, n. 40; Gram. Æg. p. 4, n. 3.)

6. The Egyptian literature was, in general, a syllabic writing ("Rudimenta," p. 25, § 16; p. 39, § 35; p. 40, n. 107; p. 41, n. 110): regularly each of the 630 hieroglyphs expresses syllabically the consonants contained in the name of the figure. (Transactions of the first meeting of the Germ. Or. Soc'y, 1845; Gram. Æg. p. 8.) A great many syllabic hieroglyphs were first published in 1833 (Astron. Æg. etc.) and 1840 (Alphabeta genuina, etc.), and 1843 (Grundsätze d. Mythol.), and 1844 (Leipz. Repert. vol. iii. p. 300), apart from those in the "Rudimenta hieroglyphices, L. 1826. (See Leip. Repert. 1852, n. 26.)

7. The Egyptians were not very scrupulous in expressing similar-sounding elements of the ancient dialects; they expressed, e.g., the letters ⲁ, ϩ, ϫ, ח, '(g), כ, ϭ(gh), ק, by the same hieroglyphs (Rudimenta, p. 23). Besides, the Egyptians distinguished the sexes of the animals, and changed some original names of the latter in later times, e.g., ⲥⲏⲣⲓ (the child) into ϣⲏⲣⲓ, to the effect that some hieroglyphs represented different letters in different times.

As soon as my discovery was (though imperfectly) published, in 1826, and my syllabic hieroglyphs were sent out, in 1845, the Champollionists clandestinely appropriated the substance of my theory and my syllabic hieroglyphs, first Lepsius, then Brugsch, then Rougé, and so forth. The only savans, known to me, who respected my discoveries, and defended them against envious *flibustiers*, were Prof. M. Uhlemann in Göttingen, and Prof. H. Wuttke in Leipzig. It is a great loss that the former—the author of many valuable works, the indefatigable vindicator of the truth, who was much better qualified to promote Egyptian philology than all the Champollionists together—died in the bloom of his life. He will allow me to put this triumphant laurel upon his grave-stone. Not less the premature loss of Prof. Wuttke—who repeatedly exposed the public error of supposing that Champollion's system is the key to the whole of the Egyptian literature—deserves to be lamented. He has repeatedly chastised literary theft.

Champollion's erroneous hieroglyphic system is briefly the following:

1. The Egyptian writing originated from the primitive ideologic literature.

2. Every hieroglyphic inscription consists half of ideologic characters, explicable to everybody's fancy, and half of pure letters and abbreviated words; e.g., *o* for "onch," *s* for "suten."

3. The ideologic figures are either mimetic, or allegoric, or enigmatic. This foolish doctrine originated from misunderstanding Clement of Alexandria (Strom. v. 4), where *συμβολικός* means "syllabic" and not "ideologic," because *συλλάβειν* and *συμβάλλειν* are synonymous.

4. The phonetic hieroglyphs are determined by Greek and Roman proper names: and some other groups, severed from the contexts, and arbitrarily spelled.

5. Not one of the 630 hieroglyphic figures signifies a syllable (*point syllabique*).

6. Regularly all hieroglyphic groups are followed by one or more ideologic figures, indicating to what class of things the preceding word belongs.

7. The language, being the ground-work of the whole Egyptian literature, is the modern Coptic, as taught in our grammars and dictionaries.

It is apparent that Champollion's system totally differs from that of the author, and it is self-evident that any hieroglyphic inscription, deciphered either according to the former or latter theories, must of necessity yield totally different meanings. It is therefore an important question: *What is the true key to the Egyptian literature?* For my part, I am not at all personally interested in the matter, for I never longed after an idle nimbus, but always worked for the glory of Him who is the truth, and condemns all sorts of falsehood. I have nothing to gain or to lose for myself. The question is of some account, only, because the whole civilized world wants to know what are the contents of those thousands of papyrus scrolls and inscriptions which Providence, during a period of 4658 years, has preserved. Further, by means of this ancient literature it is to be decided whether the traditions of all other nations of old, especially the Hebrews, are reliable or not. Moreover, the European governments pay annually great sums for the purpose of bringing useful truths to light, and many friends of science purchase Egyptian works at high prices to the end of being instructed, and not for being cheated and led astray. For these reasons we are in duty bound to enter into the question.

In the first place, it will be objected that the correctness of Champollion's system has, since 1824, been placed beyond question. *Quod non!* For no hieroglyphic system can be true as long as it contradicts clear evidences; and this is the case with Champollion's theory. (See my Gram. Æg. pp. xix. xxvi. 4.)

The principal argument, however, is that from 1824 down to this day none of the Champollionists succeeded in grammatically and logically interpreting any, either bilingual or not bilingual, entire Egyptian text. For in 1845, 21 years after the publication of Champollion's Préces, Bunsen (Ægyptens Stellung in der Weltgeschichte, vol. i. p. 320), in accordance with Lepsius and Birch, came out with the following declaration: "We declare decidedly that there is not a man alive who could read and explain [according to Champollion's system] any whole section of the [Turin] Book of the Dead, much less a historical papyrus."—Champollion himself, although repeatedly challenged to verify his theory by a translation of the Rosetta-stone, never succeeded in explaining it.—Brugsch, indeed, published in 1851 an interpretation of the Rosetta, but he could not do it without deserting Champollion's standard, and clandestinely applying my syllabic hieroglyphs. Moreover, this work differs very much from Uhlemann's "Interpretatio Rosettanæ," 1853. (See Leipziger Repertorium, 1852, p. 26; 1853, p. 278.)—Further, in 1851 Rougé's "Mémoire" appeared, in which he honestly confessed "que la traduction des ces lignes eût été impossible dans l'état où Champollion a laissé la science égyptienne"; but he cunningly concealed that his translation was based upon my syllabic alphabet, of which a copy was given to him by his friend Brugsch at Berlin. (See Leipziger Repert. 1853, p. 155.)—Again, in 1866 Lepsius's interpretation of the Tanis-stone made its appearance, but, alas! a great deal of the text remained inexplicable, although he availed himself of my theory and syllabic hieroglyphs. By the way, in the same year Reinisch's "Zweisprachige Inschrift von Tanis" came out, and this translation, made according to the same "key," totally disagrees with Lepsius. The latter promised, eleven years ago, to publish a commentary to his translation of the Tanis-stone, and yet this commentary never appeared, and never will come out, because it was and is impracticable to comment on a translation proceeding from a wrong theory. Finally, the fact is obvious that any Egyptian inscription, if translated according to Champollion's statements, yields the greatest absurdities, as Champollion's "Grammar and Dictionary," Brugsch's "Rosettana," De Rougés "Mémoire," Lepsius's "Tanis-stone," the publications of the "Society of Biblical Archæology," Ebers' Papyrus, etc., most assuredly evidence. The following examples may be specified:

Champollion tells us that "the Egyptian calves had always much thirst for *waves* of water"; that Ramses was called "Soleil, gardien de la vérité"; that "Osimandya" signified "ami de Phthah *Nubnubei"*; that there existed in Egypt "a serpent thirty cubits in length, fifteen cubits broad, and only four cubits thick." Rougé's Mémoire (p. 64) translates the words, "I am the lord, amidst the pleasures of the house situated on the border of the valley," thus: "Narrabo etiam nomen anguis illius, qui in monte suo; habitans in igne suo; nomen ejus *Anheho*, being 30 cubits long, 15 cubits broad, and four cubits thick." The same Champollionist discovered that, in Moses' days, "sept décorations de la valeur militaire, les colliers d'or," existed. Similar examples will be found in Leipzig. Repert. 1852, p. 26; 1853, p. 155. By means of the same system Lepsius and Brugsch discovered a great many monster words, e.g., *aaau*, arms; *aaan*, cynocephalus: *aaain*. time; *uaa*, to swear; *uau*, to well; *futu*, greater; *oau*, flesh; *taau*, rope; *tuau*, praise; *ua*, cheek; *chu*, goods; *sechairi*, father; *ou*, all; *oau*, office; *oo u*, dignity; *aa*, chief; *chaa*, popular; *u*, way; *ut*, instantly—and a legion of similar words, occurring in no dictionary and in no language. Brugsch and Ebers discovered that a gallon of Lagerbier (*sic!*) was, 1500 years B.C., the dosis for a sick man, and that honey (i.e. melissa, apiastrum) belonged to the officinal plants.

These facts, that Champollion's System is irreconcilable with the most explicit reports of the ancients; that the most learned Egyptologist repeatedly declared this theory to be, in general, and apart from some specialties, preposterous; that by the instrumentality of Champollion's doctrine it was impossible to decipher a great many royal proper names; that no Champollionist, from 1824 down to this day, succeeded in translating any Egyptian text completely, viz. grammatically and logically, much less the Rosettana and the Tanis-stone; that all who followed Champollion in interpreting Egyptian texts, obtained the most absurd results and numberless monster words;—these facts, I presume, should suffice to convince every intelligent unprejudiced man that Champollion's theory, so far as translating entire hieroglyphic texts is concerned, was a complete failure.

However, the question is: what shall we do in order to eradicate these noxious weeds? Shall we leave the Champollionists unmolested, hoping that they will confess their sins voluntarily? God forbid! For it is extremely hard for ambitious men to confess faults; and whoever keeps silence in the face of false doctrines becomes an accomplice. *Amicus Plato, magis amico veritas!* It is true, I have from 1826 down to this hour combatted the Champollionists, but in vain; and it is at present apparent that other steps must be taken for protecting the public from the present Egyptian humbug. I cannot excuse myself from the duty of bringing the very nature of Champollion's system to light—to show what are the real values of the thousands of Egyptian works published since Champollion's Précis, and based upon his theory—to warn other Egyptologists against propagating palpable errors—to guard the literary world from future impositions of this kind—to enable every scholar to promote Egyptian philology by translating Egyptian texts grammatically and logically, and thus to revive the oldest literature of the world. This is the great problem of the present century; but, down to this moment, nobody, during fifty-four years, could by means of Champollion's system really interpret any Egyptian inscription. Champollion's Dictionary, Brugsch's interpretation of the Rosettana and his big Dictionary, Rougés Mémoire, Lepsius's Tanis-stone (particularly the four volumes, "Records of the Past," published by the Society of Biblical Archæology"), etc., are deplorable guess-works, nothing else. Moreover, it is everybody's office to preserve—according to the universal rule, *suum cuique*—honesty in literary society, and to punish the shameful sin of appropriating others' property, repeatedly committed by the Champollionists.

Therefore I am under obligation, first, to publicly challenge Lepsius to translate and explain our astronomical inscription, grammatically and logically, according to Champollion's principles and alphabet. In so doing, however, he must not have recourse to syllabic hieroglyphs. For Champollion in all his publications maintained (see the passages in the author's Gram. Æg. pp. xvii. xviii.) that no hieroglyph signified two or more consonants. Should Lepsius, however, notice that our inscription cannot be explained without taking 54 hieroglyphic figures for syllabic signs, he is morally bound to confess publicly that he grievously erred in declaring Champollion to have discovered the key to Egyptian literature, and my own system to be the outcast of literary productions. The latter he has done in all his public and private lectures and writings. Let him not recur to another misstatement, that he himself discovered the syllabic hieroglyphs. For the law that the Egyptian literature was, in general, a syllabic one, and that certain figures expressed certain consonantal syllables, was discovered in 1826, eleven years prior to Lepsius's Egyptian career. His syllabic hieroglyphs, published in Bunsen's work ("Egypt's Place," 1845), were preceded by those in my "Astronomia Æg." 1833, those in my "Grundsätze," 1843, and by the 30 syllabic hieroglyphs in my "Alphabeta genuina," 1840, fixed five years prior to Bunsen's "Egypt's Place," 1845. Besides, Lepsius ignoring that regularly each of the 630 hieroglyphs represents the two or three consonants contained in the name of the figure, it came to pass that nearly all his syllabic figures were erroneously determined. May Lepsius remember that it is not shameful to confess blunders, nor to make reparation to injured men, and that he remains responsible for every untruth and calumny. (See Leipz. Repertor. 1849, vol. ii. p. 6.)

The Champollionist Brugsch, having denied the existence of syllabic hieroglyphs down to 1851, suddenly changed his opinion as soon as he received my printed syllabic alphabet, and then he translated the Rosetta-stone in 1851 by clandestinely adopting my syllabic hieroglyphs. (See Leipz. Repertor. 1852, p. 26.) He took 122 hieroglyphs for syllabic signs, of which nearly all were first determined in my pamphlet transmitted to Brugsch, whilst not a jot of them is to be found in Champollion's works. Now, what did our Champollionist do? He began his work with the imposition that it was Champollion who discovered the syllabic hieroglyphs and the key to the Egyptian literature, and that my discoveries are "vana ficta" — "docti viri tanto plus se profecisse arbitrati, quanto mirabiliora auditu in medium protulissent." This ignoble conduct of soiling another's name, and then appropriating his property, will meet with its just award. Since, however, the revival of Egyptian literature depends principally on the syllabic hieroglyphs, we challenge this short-sighted polyhistor to produce the passage where Champollion retracted his doctrine that "no hieroglyph expressed a syllable," and to show a plate where the same determined the syllabic values of the 630 or less hieroglyphic figures. Moreover, we challenge Brugsch to interpret our inscription grammatically and logically by the real system of the "great master." Should he, however, fail to accomplish the problem without my syllabic hieroglyphs, he is morally obliged to confess his calumnies and literary spoliations. He will not forget that he is a responsible being. By the way, these very same crimes were committed in De Rougé's Mémoire, Par. 1851 (see Leipz. Repert. 1853, p. 155). The author, deserting Champollion's system, took 24 hieroglyphs for syllabic characters, as they were first determined in my lithographed pamphlet, of which a copy was in his hand. I am sorry that this laborious man left this world with the brand of calumny and plagiarism on his name.

Furthermore, nobody before me (Rudimenta, 1826) has taught that the language of the ancient Egyptians was related with the Hebrew (Rudimenta, p. 13, n. 37). In the same work, several Hebrew words, obvious in the original Egyptian literature, have been mentioned (p. 14, n. 38; p. 13, n. 37; p. 47, n. 5; p. 48, n. 7; p. 49, n. 17; p. 59, n. 7; p. 62, n. 5; p. 65, n. 3; p. 70, n. 9; p. 72, n. 22, &c.) My Grundsätze, etc., L. 1843, p. 222, etc., likewise reduced Coptic words to Hebrew roots. Moreover, the same was done in my syllabic alphabet (1846), e.g. in the following 63 places: Nos. 13, 43, 45, 61, 116, 120, 123, 130, 144, 165, 173, 182, 186, 187, 190, 191, 202, 212, 214, 215, 218, 226, 245, 253, 269, 279, 281, 312, 416, 439, 441, 455, 464, 469, 493, 517, 519, 520, 521, 524, 531, 559, 560, 561, 571, 588, 589, 616, 617, 620, 623; pp. 55, 61, 65, 67, 73, 74, 80, 83, 85, 86, 87, 87. Many other examples of this kind will be found in my Grammatica Æg., in the commentary to the hieroglyphic alphabet, and in my "Theologische Schriften," etc., L. 1855, pp. 117, 118. Since nobody prior to 1826 has taught and by many examples demonstrated that the Hebrew language preserved both the roots and original forms of numberless hieroglyphic words, whilst

Benfey's book appeared in 1844, i.e. eighteen years after my Rudimenta, it is another misstatement what the truth-loving Brugsch says in his Dictionary, vol. iv. Pref., "that his friend Benfey ('Ægyptische und Semitische Sprache,' 1844), *first of all*, had demonstrated the affinity of the Coptic with the Hebrew." Besides, Benfey has not at all reduced Coptic words to Hebrew roots, as I have done, but acquiesced in paragoning a small number of Coptic particles with Hebrew ones. The Hebrew words which appear in Brugsch's Dictionary are to a great extent the same which I had determined a long time before, e.g. in my Theologische Schriften, pp. 117, 118; and I admire the sagacity by which Brugsch, totally ignorant of the Hebrew, derived, e.g. тєв, the finger, from אצבע (eqhba), finger, as I have done in the said place. It is not my intention to whitewash a great mass of blunders obvious in my "Rudimenta," but their substance was and will be true for all time to come, namely, that the hieroglyphic literature was not an ideologic but a syllabic writing; that regularly each of the 630 hieroglyphs signified the consonants contained in the name of the figure, and that the language of the ancient Egyptian was the ancient Coptic, allied to the Hebrew and the primitive Chaldaic language.*

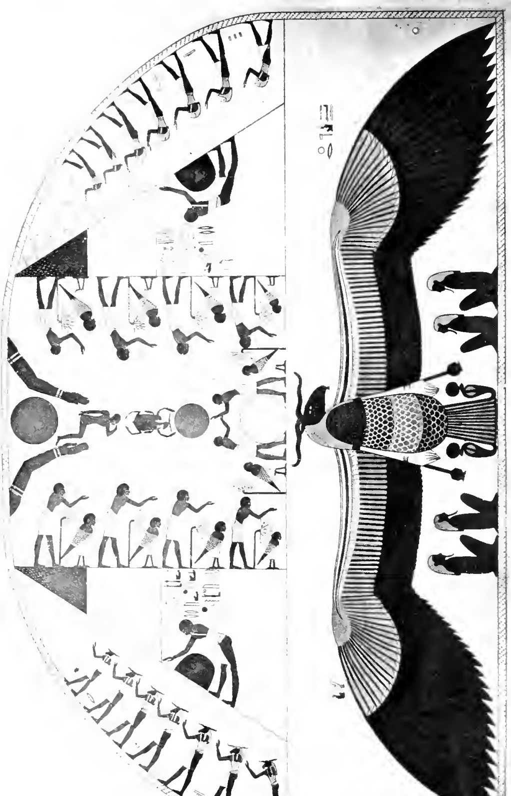
We come now to another calumniator of my system, a new propagator of Champollion's imaginings, namely, Prof. Ebers, in Leipzig. This perfect pupil of Lepsius has not hesitated to declare, in all his public and private lectures, Champollion's system to be the key to the whole Egyptian literature, but my own to be the greatest nonsense. These attacks have been repeated even in New York papers. Well, then, Champollion's theory being the key to the whole Egyptian literature, Prof. Ebers will be so

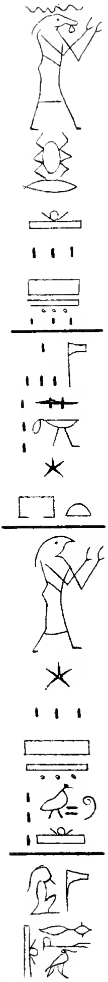
* A very clear example exhibiting Brugsch's natural instinct is the following. In 1826, I discovered on a Turin altar the first geography of ancient Egypt, the basis of Brugsch's geographical researches, which was published in the author's Astronomia Æg. etc. 1833, Pl. II., No. 2. Brugsch had never seen this catalogue of seventy-two Egyptian cities, and yet in his Egyptian Geography, 1857, vol. i., pl. 57, an exact copy of the names of the same cities will be found. Since, then, Brugsch regularly praises the smallest supposed discoveries of a Champollionist; since he has repeatedly declared all my discoveries to be "vana ficta"; since he did not mention with so much as a word who discovered the geographical altar of Turin,—it is evident that he intended to appropriate my little discovery. No honest man knowingly takes the property of another, and nobody strips foreign feathers to decorate his own black habit. Will he publicly confess his calumny that my Egyptian studies are "*vana ficta*"?

kind as to demonstrate his thesis practically, by translating, grammatically and logically, our astronomo-theological inscription, but strictly in accordance with Champollion's requirements. He is bound to take those 82 hieroglyphs half for ideologic, half for alphabetic signs; further, to attribute to no hieroglyph a syllabic value; finally, to pronounce Champollion's phonetic hieroglyphs, as he has done in his Grammar and other works, and not to recur to the Hebrew language;—for these are the principal rules of the "great master's" system. Should Prof. Ebers, however, fail to accept this public challenge, and deny satisfaction to the injured truth, then I shall, in the name of the whole scientific world, call him simply a calumniator and cheat.

In conclusion, I cannot forbear to remind the Rev. P. Le Page Renouf, a member of the Catholic University of Ireland, of the provocation published in these Transactions, vol. i. 1860, p. 569, to wit, this most refined pasquilant among the greatest lampooners having crowned Champollion's system in "Atlantis, a Register of Literature and Science, conducted by members of the Catholic University of Ireland" (London, 1859, vol. iii. p. 74), libelled my own theory, e.g. thus: "Seyffarth's theory is fundamentally unsound, and simply illusory"; "it is apparently impossible to learn or teach it"; "if this be the key, it would be a sufficient answer to say, that with such an instrument it would be as possible to decipher texts as to open real doors with an ideal key"; "there is no arguing with people who talk such nonsense," and the like. These false invectives were rebuked at the end of my treatise, concerning the funeral papyrus, once in possession of Gen. Geo. A. Stone of Roxbury, found on the body of the same Egyptian general with whom King Shishak, in 945 B.C., conquered Palestine. My provocation (p. 569), soon after transmitted to P. Renouf, reads thus: "In case the representative of the "orthodox school" should not succeed in translating and explaining the sixteen lithographed pages, in a satisfactory manner, according to Champollion's principles, Grammar and Dictionary, then I shall ask the learned world to take the reverend reviewer for a gross and shameless calumniator." Nevertheless, the latter has from 1860 to this day neglected to translate the said parts of Stone's Papyrus according to "the orthodox system"; wherefore he is once more challenged to accomplish the task, and at the same time to interpret our theological inscription according to Champollion's theory, viz.. without taking any hieroglyph for a syllabic sign, or reducing any hieroglyphic word to a Hebrew or related root. Should he, however, perceive, that no entire Egyptian text can be explained grammatically and logically by means of Champollion's "orthodox system," he will not hesitate, if desirous to leave an honorable name, to confess publicly that Champollion's theory was, apart from a small number of (130) letters and words, a complete failure. It is shameful to continue singing the hymn: *Mundus vult decipi, ergo decipiatur.*

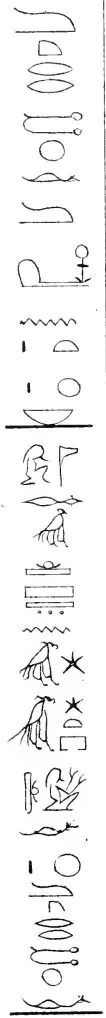
Indeed, it is afflicting to see how the Champollionists, during fifty-four years, hindered the progress of Egyptian philology; that a thousand works conspired for the purpose of trampling underfoot what was opposed to Champollion's glory. Among these deceitful publications the following, e.g., are to be numbered: Lepsius's Egyptian Journal; Brugsch's Rosettana and romances, particularly his voluminous Dictionary; De Rougé's Mémoire; Lepsius's Tanis-stone, "The Reports of the Past," &c. Of the latter work, nearly every year one volume, containing only translations, is published by the London Society of Biblical Archæology. The character of these translations, however, is clearly mirrored in Goodwin's version of the Neapolitan stele (vol. iv. p. 65), which translation of twenty lines is true in four instances only, as will be seen in another place. That respectable Society ought to bear in mind that Egyptian translations, without the original texts and grammatical commentaries, are useless; that they spread the old error that Champollion's system is the key to Egyptian literature, and that this corporation is responsible for its publications reducing the Egyptian literature to Cimmerian darkness. Every right-minded man will approve these outspoken sentiments, because I am under obligation to protest against literary deceptions of the public. *Fiat justitia, pereat mundus!*

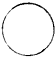
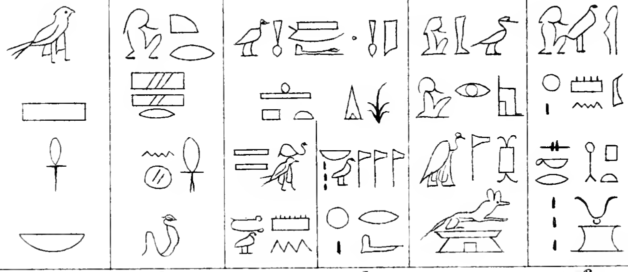




1	El	אֵיל	The seven
2	hm	ϩⲁⲙ	Cabiri,
3	tr	ⲑⲣⲉ	performers
4	km hp	ϫⲟⲙ ϩⲟⲩⲟ	of
5	kt hp	ⲕⲟⲧ	revolutions.
6	htr hp	ϩⲧⲟⲣ אדִיר	The gods
7	sp kt hp	ⲙⲟⲛ ⲕⲟⲧ ϩⲟⲩⲟ	revolving in the
8	kb tb	ⲑⲉⲃⲓ כָּב תֵּבָה	starred cave.
9	kr	ϫⲟⲣ	The seven
10	hm	ϩⲁⲙ	Cabiri,
11	kb hp	כּוֹכָב ⲥⲓⲟⲩ	the stars
12	kt	ⲕⲟⲧ	revolving
13	pt km hv	ים ות ϩⲟⲩⲟ	ones.
14	htr hm	ϩⲧⲟⲣ אדִיר ϩⲁⲙ	The gods
15	nh km	ⲛⲁⲁ ϫⲟⲙ	great

16		kt	ⲕⲟⲧ	revolving in
17		nkbh	ⲛ ⲕⲏⲡⲉ	the vault of
18		kb tbh	ⲉⲓⲟⲩ ⲑⲃⲁⲓ	the starry heaven,
19		ks	ϭⲓⲥⲓ	the praisers
20		km hb	ϫⲟⲙ ϩⲱⲃ	of the
21		kr m	ⲟⲩⲣⲟ κύριος	Lord in
22		kll	ⲙ̀ ⲕⲗⲟⲟⲗⲉ	darkness,
23		trf	ⲑⲣⲉ—ϥ	their Creator.
24		hm	ϩⲉⲙⲓ	The twelve governors,
25		htr hm	ϩⲧⲟⲣ ϩⲁⲙ	the gods
26		na km	ⲛⲁⲁ ϫⲟⲙ	great
27		kt	ⲕⲱⲧ	revolving in
28		kb tb	ⲉⲓⲟⲩ ⲟⲃⲁⲓ	the starry cave,
29		ks	ϭⲓⲥⲓ	the praisers
30		hb	ϩⲱⲃ	of the
31		kr hm	ⲟⲩⲣⲟ ϩⲁⲙ	Lord governor,

32		m	ⲙ̀	the
33		kll	ⲕⲗⲟⲟⲗⲉ	invisible,
34		tk f	ⲧⲟϫ—ϥ	their Creator,
35		m	ⲙ̀	in the
36		onk ma	ⲟⲛϩ ⲙⲁ	dwelling
37		nt	ⲛⲧⲉ	of the
38		kr kl	ⲟⲩⲣⲟ ϫⲟⲗ	Lord of the universe.
39		hm htr	ϩⲁⲙ ϩⲧⲟⲣ	The twelve gods
40		anh km	ⲛⲁⲁ ϫⲟⲙ	great
41		kt	ⲕⲟⲧ	revolving
42		nkbh	ⲛ̇ ⲕⲏⲡⲉ	within the vault
43		kb tbh	ⲥⲓⲟⲩ ⲑⲃⲁⲓ	of the starry heaven,
44		ks km	ϭⲓⲥⲓ ϫⲟⲙ	the praisers
45		hb kr	ϩⲱⲃ ⲟⲩⲣⲟ	of the Lord Creator,
46		m kll	ⲙ̀ ⲕⲗⲟⲟⲗⲉ	the invisible,
47		tk—f	ⲧⲱϫⲉ—ϥ	their Creator.

48		kr hpt	ϭep כָּבוֹד	The gardens
49		km	ϫⲱⲙ	of the souls.
50		hm hb htr	ϩⲁⲙ ϩⲱⲃ קָדָר	The invisible Creator.
51		El	אֵיל	The Almighty,
52		hpt hm	ϩⲱⲡⲧ ϩⲁⲙ	the Creator.
53		kr	ⲟⲩⲣⲟ κύριος	The Lord
54		htr hm	ϩⲁⲙ ϩⲧⲟⲣ	of the deities
55		na km	ⲛⲁⲁ ϫⲟⲙ	the great ones.
56		kl	ϫⲱⲓⲗⲓ	The house
57		kr	ϩⲣⲁ حور	of the sun.
58		kr	ⲟⲩⲣⲟ אֵל ⲑⲣⲉ	The Lord
		el tre	ϩⲧⲟⲣ	Creator.
59–62				

a b c d e f

Report on Magnetic Observations in Missouri, Summer of 1878.

By FRANCIS E. NIPHER, Professor of Physics
in Washington University.

In connection with meteorological work done under my direcrection, it was deemed of importance to determine the elements of terrestrial magnetism for various points in Missouri. Being aided by the kind coöperation of the U. S. Coast Survey, the summer of 1878 was devoted to this work.

The following is a list of the instruments and appliances taken with us:

1 Portable Declinometer and stand.
1 Five-inch Altitude and Azimuth Instrument.
1 Intensity Magnet, marked C_6.
1 Smaller " " C_{17}.
1 Dip Circle, with two Needles 9½ inches long.
1 Lloyd's Needle.
2 Eleven-inch Bar Magnets.
1 Watch, Jurgensen, No. 10890.
1 Wall Tent, 5×7 feet base.

These articles, with the exception of the last two named, were furnished by Prof. J. E. Hilgard, of the Coast Survey.

I was accompanied by Messrs. J. W. Shaub, F. Nicholson, and L. H. Ritterskamp, students of Washington University.

The observations on dip were nearly all made by Messrs. Nicholson and Ritterskamp, these gentlemen taking turns in observing and recording.

The observations for meridian were all made by myself, the time being determined and record made by Mr. Shaub.

In the observations for intensity, nearly all the observations on the magnet scales were made by myself, Mr. Shaub taking time and making the record.

Determinations of latitude and longitude were made from the Land Office map, by means of the county and section lines.

The calculations for declination were made independently by Mr. Shaub and myself, and the reduction for dip, made by Nicholson and Ritterskamp, was afterwards revised by Mr. Shaub and myself.

The calculation for intensity, involving a redetermination of the constant *q*., and a determination of the change of the moment of inertia of the magnet for a change of 1° F. in its temperature. were all made by mself.

The gentlemen who accompanied me paid their own expenses, or were aided by friends, and the other expenses of the work were paid in part by Mr. Wayman Crow and Dr. W. G. Eliot.

My thanks are also due to the following Railroads, which have very kindly encouraged us with passes: St. Louis, Kansas City and Northern; Missouri Pacific; San Louis and St. Francisco; Missouri, Kansas and Texas; St. Louis, Keokuk and Northwestern; Missouri, Iowa and Nebraska.

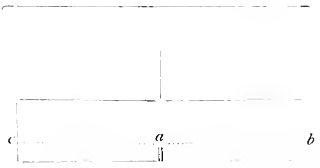
My thanks are also due to the gentlemen who accompanied the expedition, who were often put to great physical discomfort; and to Mr. A. D. Jaynes of Sedalia, whose hearty coöperation and personal aid were of great value.

DECLINATION.

The transit used in determining the meridian, and in observing the magnet scale, was made by Jones of London, and had evidently seen service. The vertical and horizontal circles were provided with tangent screws and double verniers, reading to the half minute.

The magnet used in determining the declination was C_6, and its axis was redetermined each day whenever this was possible. In a few instances this was not done, but subsequent determinations showed that no appreciable change had taken place. The two collimator magnets were always carried in separate cases suspended from the shoulder and with the south pole up, and were protected with great care.

The copper damper which accompanied the declinometer was never used. The following device was found much more satisfactory. A thin brass wire, suspended in the angle of the stirrup below the magnet, carried a light paddle of thin sheet brass, which dipped into a vessel of glycerine.— The lower edge of the paddle



was slit vertically (as seen at *a*), and was bent upward into a horizontal position, the parts *ac* and *ab* being bent in opposite directions. With this damper vertical and horizontal vibrations were very quickly checked. This damper was first used at the Canton series, before which time no damper was used.

At Mexico and Columbia the meridian was determined by alt-azimuth observations, but, the axis of the vertical circle being much worn, it was thought better to use the method of equal altitudes.

In the former case the meridian was determined by calculating the solar azimuth from the formula :

$$\sin^2 \tfrac{1}{2} a = \frac{\cos s \sin (s - \delta)}{\cos \varphi \sin z}$$

where $z =$ zenith distance,

$\delta =$ declination of sun,

$\varphi =$ latitude of the place,

$s = \tfrac{1}{2} (z + \varphi + \delta)$.

In the second case the reading of true south is given with sufficient accuracy by the formula

$$\tfrac{1}{2} (A_1 - A) - \tfrac{1}{2} \frac{\Delta \delta}{\cos \varphi \sin t}.$$

Where A and A^1 are the readings of the azimuth circle.

$\Delta \delta$ is the change of solar declination during a time of

$2t$, which is the elapsed time,

t being taken as the hour angle of the western observation,

$\varphi =$ the latitude of the place.

At Louisiana, the loss of the diagonal eye-piece prevented us from taking the afternoon observations of a second determination. At the next station, Hannibal, an eye-piece was extemporized, and was used at all subsequent observations, although the lost eye-piece was soon forwarded to us The solar image, as seen through the prismatic eye-piece, was too brilliant.

The extemporized eye-piece was made as follows :—A cylindrical pasteboard box had mounted in it a plate of very smooth dark red glass, set at an angle of 45° with its axis. This was done by cementing it to a cylinder very accurately cut in a mitrebox. Its back face was blackened, to prevent a double image. A plate of red glass served to cut off the proper quantity of light.

The watch used in making time observations had been lying idle for two years, and it ran satisfactorily until July 22d, when it suddenly stopped. As it had been previously compared with a chronometer at Hannibal, no observations were lost. It was found that the terrible heat of the previous week* had hardened the oil of its bearings. The watch was roughly cleaned here, and thoroughly cleaned at Keokuk. Its rate was thereafter constantly checked by comparison with good regulators and railroad chronometers. A mistake was made in changing the rate of the watch (which was very great), with a view of making it smaller.

In making declination determinations, the transit was removed from the declinometer, and was placed on a stand outstide of the tent. In doing this, the whole instrument was probably moved on its stand at Wright City. Arrangements have been made to use a separate instrument as declinometer next year.

It was found after leaving Memphis that our observations there had been made over the site of a blacksmith's shop.

HORIZONTAL INTENSITY.

In these determinations the same instrument ($D._3$) was used.

The instrument was set up in the tent, the tripod standing on wooden stakes driven firmly into the ground. the tripod being first levelled on the stakes by properly driving the latter, adjusting with a hand level.

The observations made were

1. A series of oscillations with the intensity magnet.
2. Two series of deflections, C_{17} being suspended, and C_6 deflecting, at distances of 1.75 and 2.0 ft.
3. A series of oscillations with C_{17}.

The magnets were suspended on five silk fibres, which were unchanged during the whole of the determinations. (There were originally six, but one was broken in preliminary work before we set out.)

The reduction to an infinitely small arc was avoided by making the arc of vibration small.

The moment of inertia of the magnet C_6, for various tempera-

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* 104° in the shade on several successive days.

tures, was determined on returning to St. Louis, care being taken to keep the magnet in order during the trip.

The constant q was determined by the Coast Survey in 1856, and was given by Mr. Schott as $0._{00040}$. He stated that this value was rather large, and it was redetermined as shown hereafter, the resulting value being $0._{00048}$. This magnet is cracked on one side.

When the instruments were sent from Washington, the two magnets C_6 and C_{17} were packed in the declinometer box with the north poles down, the distances between their centres being two inches. In our determinations at Iowa City, it was found that the two magnets, thus placed, acted upon each other in such a way that the value of m changed greatly for every jar which the box might receive. Each magnet mutually weakened the other, and many irregular changes occurred: As it had been our intention to make only relative determinations of intensity, our work prior to that time was worthless, no deflections having been taken.

The two magnets were afterwards carried as follows:—The magnet was placed in a chamois case fitting it closely, and was then placed in the metal box; this box was then slipped into a similar case of leather, so arranged that it could be slung over the shoulder.

The magnets were always carried, south end up, on the person—never allowed to come too near each other; and in the cars were hung from the roof in such a way that they could not swing so as to receive a jar.

The value of m was least during the first week of our work, and thereafter was sensibly constant, showing however a slight increase even then. This increase is caused by the large values of m at Kansas City and Sedalia on the 4th and 7th of September, and these observations were made with extreme care.

The dimensions of the inertia ring y, given by Mr. Schott, are

Inner radius 1.1715 in. } at 62° F.
Outer " 1.4215 " }

The weight given by Mr. Schott was 813.40 grains.

Two weighings, on different balances, with different sets of weights (Becker's), gave me

Left pan, 52.6770 grammes.
Right " 52.6769 "

Mean 52.6769 "

Left pan, 52.6785 "
Right " 52.6750 "

$\sqrt{pp^1} = 52.6767$ "

Final value, 52.6768 grammes.
= 812.93 grains.

Reduction to vacuum correction may be neglected; I have, therefore, adopted the weight 812.93, presuming that the difference between this value and that given by Mr. Schott is caused by wear of the ring since it was weighed.

Taking the co-efficient of expansion as $0._{00001}$, it follows that the moment of inertia k'_t of the ring may be expressed by the formula

$$k'_t = 9.56562 + 0.000916\ t,$$

from which the following table has been constructed:

t.	k'_t
60	9.5771
70	9.5790
80	9.5810
90	9.5829
100	9.5848

O	PP.
1	2
2	4
3	6
4	8
5	10
6	11
7	13
8	15
9	17

The following determinations for the moment of inertia k_t of the magnet, at various temperatures, have been made, the reductions being obtained by means of the formula

$$k_t = k'_t \frac{T^2}{T'^2 - T^2}$$

where k'_t = moment of inertia of the ring.
T = the time of oscillation of the magnet alone,
T' = time of oscillation of the loaded magnet.

Date.	t.	log T'^2	log. T^2.	log. (T'^2-T^2)	log $\frac{T^2}{(T'^2-T^2)}$	log. k'_t	log. k_t
Sept. 30, '78	79.5	1.88112	1.68402	1.44320	0.24082	0.91840 ...	1.22222
Oct. 1,	79.5	1.86000	1.68392	1.38286	0.30106	0.98140 ...	[1.28246]
" 1,	81.6	1.87840	1.68341	1.43678	0.24663	0.98142 ...	1.22805
" 2,	75.7	1.87917	1.68270	1.44014	0.04256	0.98137 ...	1.22393
" 3,	74.7	1.88012	1.68283	1.44253	0.24030	0.98136 ...	1.22166
" 3,	77.7	1.88011	1.68224	1.44351	0.23873	0.98139 ...	1.22012
Feb. 26, '79	61.0	1.89937	1.70296	1.46024	0.24272	0.98124 ...	1.22395
" 27,	62.0	1.89744	1.70047	1.45929	0.24118	0.98125 ...	1.22243
Mar. 11,	68.0	1.89820	1.70213	1.45847	0.24366	0.98130 ...	1.22496
" 11,	77.0	1.89836	1.70126	1.46043	0.24083	0.98138 ...	1.22221
Means	73.7	....	....	....	....	....	k_0 = 1.22328

Assuming $\log. k_t = \log. k_0 + (t - 73.7) \triangle k$.

Where $\triangle k$ is the charge in log. k_t for 1° F., we have from the nine observations above, nine equations, of the form

$$e = \log. k_0 - \log. k_t + (\tau - 73.7) \triangle k, \text{ or}$$
$$e = y + u.\triangle k.$$

The value of $\triangle k$ which best satisfies these equations is

$$\triangle k = - \frac{[uy]}{[u^2]}$$

4th place. y.	u.	uy.	u^2.
+ 10.5	+ 5.8	+ 60.9	33.64
− 47.7	+ 7.9	− 376.6	62.41
− 6.5	+ 2.0	− 13.0	4.00
+ 16.2	+ 1.0	+ 16.2	1.00
+ 31.6	+ 4.0	+ 126.4	16.co
− 6.8	− 12.7	+ 86.4	151.29
+ 8.5	− 11.7	− 99.5	136.89
− 16.8	− 5.7	+ 95.8	32.49
+ 10.7	+ 3.3	+ 35.3	10.89
	Sums	− 68.3	448.61

$$\triangle k = + \frac{68.3}{448.61} = 0.152;$$

hence

$$\log. k_t = 1.22328 + 0.0000152 (t - 73.7.)$$

From this formula the following table has been prepared:

Magnet C_6.

t.	log. k_t
50	1.22292
60	1.22307
70	1.22322
80	1.22338
90	1.22353
100	1.22368

F.°	P. P.
1°	2
2	3
3	5
4	6
5	8
6	9
7	11
8	12
9	14
10	15 exact.

Determination of q for C_6.

The deflecting magnet C_6 was surrounded by a copper jacket, with water lining of one inch thickness, so arranged and so heated as to produce a circulation of the water.

In order to correct for varying declination, the magnet C_6 was removed at each reading, and the position of C_{17} read.

A glycerine damping was used, so that the scale was perfectly steady. When C_6 was removed, it was always retained in the jacket, lying on cotton batting.

For the cool temperatures ice-water was used, and the same was kept at constant temperature by cooling the room first, and then feeding the water in the jacket by a constant drip of ice-water.

In the first determination, at 7h. 49m. a.m., all the magnets had been thus in position all night, so that the temperature of C_6 was determined with sufficient certainty.

Determination of q for C_6.

March 20, 1879.

C_{17} suspended. Glycerine damping.

C_6 deflecting 21 inches west; north pole west.

Temperature of room 58°.3 F.

Hour. A.M.	Temp.	C6 deflect. Scale C17.	C6 removed Scale C17.	Angle of deflection.	Remarks.
h. *m.*					
7 49	53·	155·7			
7 53			79·25	76·40	
7 58	52·5	155·6			C_6 not removed.
8 02	52·7	155·4			
8 06			79·10	76·55	Jarred C_6 lightly.
8 09	52·7	155·9			
8 14			79·25	76·50	
8 20	53·2	155·6			
	52·8			76·48	

C_6 gradually warmed.

TEMPERATURE OF ROOM 70°.

Hour. P.M.	Temp.	C6 deflect. Scale C17.	C6 removed Scale C17.	Angle of deflection.	Remarks.
n. *m.*					
0 7	99·0	156·1			
0 11			81·3	74·8	
0 15	98·0	156·1			
0 35	99·0	156·2			
0 39			81·7	74·6	
0 52	95·0	156·4			
0 56			81·8	74·65	
1 06	99·0	156·5			
	98·0			74·68	

Magnet laid on table on cotton batting, and room allowed to cool gradually by shutting off heat and opening windows more and more; finally put in bath as before, at 2h. 05m. p.m.

Scale before deflection 81.0
" after " 157.1 at 2h. 08m.

TEMPERATURE OF ROOM 65°.

Hour.	Temp.	C6 deflect. C17 reads.	C6 away, C17 reads.	Angle of deflection.	Remarks.
h. m.					
2 45	51.0	157.3			
2 50			81.0	76.25	
3 01	52.0	157.2			
3 05			80.9	76.20	
3 11	55.	157.0			
3 20	55.	157.0			
3 21			80.9	76.10	
3 30	55.0	157.0			
	53.6			76.18	

Results and Computation.

t.	Scale Deflection.	Scale Differences.	Differences t.
52.8	$76.^d48$	$1.^d80$	$45.^\circ2$
98.0	74. 68	1. 50	44. 4
53.6	76. 18		

Calling s = scale value of C_{17};

u = deflection at the lower temperature t_0 $(= 76^d33, = 3^\circ 40' 6)$;

l = length of 1′ in units of radius;

d = change in deflection of C_{17} for change of temperature of

$t - t_0$ $(= 44^\circ.8)$; then

$$q = \left\{ \frac{s.\ d.\ l.\ \cot u}{t - t_0} \right\}$$

log cot u (= 3°40.59)	=	1.192
log s (= 2.89)	=	0.461
log l	=	6.464
log d (= 1.65)	=	0.217
a. c log $(t - t_0)$ 44.8	=	8.349
log q		6.683

$q = 0.00048$

Hence the following table for the correction of the oscillation series:

$t' - t$	log. $[1 - (t' - t)\, q]$
− 6	0.00125
− 5	0.00104
− 4	0.00083
− 3	0.00062
− 2	0.00041
− 1	0.00021
0	0.00000
+ 1	9.99979
2	9.99958
3	9.99937
4	9.99917
5	9.99896
6	9.99875
7	9.99854
8	9.99833
9	9.99812

where t' = temperature of oscillation series, and t = temperature of deflection series.

Determination of the Quantity P for the Work of the Summer of 1878.

Assuming the deflection formula

$$\frac{m}{H} = \tfrac{1}{2}\, r^3 \tan u \left\{ 1 - \frac{P}{r^2} \right\}$$

the two determinations of $\frac{m}{H}$ made at each station with the determined values

$$\begin{matrix} r & u \\ r' & u' \end{matrix}$$

give, on the assumption that $\frac{m}{H}$ is constant for the two series

$$P = \left\{ \frac{r^3 \tan u - r'^3 \tan u}{r \tan u - r' \tan u.} \right\}$$

Work of 1878.—Determination of Constant P.

Station.	Date.	log $r^3 \tan u$.	log $r'^3 \tan u'$.	log $r \tan u$.	log $r' \tan u'$.	A log $r'^3 \tan u -$ $r^3 \tan u'$.	B log $r \tan u -$ $r' \tan u'$.	$\log \frac{A}{B} = \log P$.	P.
Iowa City	July 7	9.55996	9.56087	8.95790	9.07479	6.88081	8.44762	8.43318	+0.0271
St. Louis	" 10	9.50661	9.51081	8.90455	9.02473	7.49416	8.40807	9.08609	+0.1219
St. Charles	" 11	9.51504	9.51165	8.91298	9.02557	7.40483	8.38417	9.02066	—0.1049
Wright City......	" 12	9.50598	9.50596	8.90392	9.01988	5.11394	8.38970	6.72424	—0.0005
Mexico	" 13	9.49284	9.49240	8.89078	9.00632	6.50515	8.37475	8.13040	—0.0135
Columbia........	" 15	9.49705	9.49480	8.89499	9.00872	7.21219	8.37125	8.84093	—0.0693
"	" 17	9.50630	9.50660	8.90424	9.02052	6.34242	8.39146	7.94096	+0.0087
Louisiana........	" 20	9.51535	9.51581	8.91329	9.02973	6.54407	8.40106	8.14301	+0.0139
Hannibal	" 22	9.52139	9.51871	8.91933	9.03263	7.31175	8.39366	8.91809	—0.0828
Canton	" 24	9.53052	9.52433	8.92846	9.03825	7.68124	8.38734	9.29390	[—0.1967]
Keokuk	" 31	9.51975	9.52339	8.91769	9.03731	7.44560	8.41888	9.02672	+0.1063
Memphis.........	Aug. 1	9.52292	9.52603	8.92086	9.03995	7.37840	8.41986	8.95854	+0.0909
Kirksville	" 3	9.53143	9.52968	8.92937	9.04360	7.13672	8.40773	8.72899	—0.0536
Macon	" 6	9.51782	9.51581	8.91576	9.02973	7.18184	8.39300	8.78884	—0.0615
St. Louis	" 14	9.51038	9.50955	8.90832	9.02347	6.79239	8.39050	8.40180	—0.0252
Kansas City......	Sept. 4	9.50419	9.50277	8.90213	9.01669	7.01703	8.38202	8.63501	—0.0432
"	" 6	9.52895	9.52810	8.92689	6.04202	8.82608	8.40915	8.41693	—0.0261
Sedalia	" 7	9.50446	9.50420	8.90240	9.01812	6.27875	8.38721	7.89154	—0.0078
Vinita, Ind. Terr.	" 9	9.46392	9.46451	8.86186	8.97843	6.59107	8.35027	8.24080	+0.0174
St. Louis	Oct. 11	9.51721	9.51561	8.91515	9.02953	7.08279	8.39410	8.68869	—0.0488
								Mean....	—0.0179

The indiscriminate mean of these values (P) is —0.0179.

Peirce's criterion rejects Canton observ., and the mean of the remaining values is — 0.00805.

Hence the special values of the factor $\left(1 - \frac{P}{r^2}\right)$ become

$$\left\{1 - \frac{P}{(1.75)^2} = 1.00265 \quad \log = 0.00115\right.$$

$$\left\{1 - \frac{P}{2^2} = 1.00201 \quad \log = 0.00091\right.$$

which values have been used in the reduction of all the observations.

Change of Magnetic Moment of C_6.

The magnet C_6 seems to have changed much more during the summer than was to have been expected. This was, without doubt, caused by the interaction of the two magnets upon each other prior to July 7th.

The value of m appears to have reached a minimum about July 10th. It was more nearly constant during the latter part of the summer, but even then changed so abruptly as to make an analytical expression almost absurd.

These facts are exhibited in the annexed table, which gives a reduction of the observed magnetic moment m_t to tthe mean temperature of the series, which is done by the formula

$$m = m_t \left[1 + (t - 89.5)\, q \right],$$

where m indicates the magnetic moment at a temperature of 89°.5 on the successive days. The logarithms of these values are given in the next table. For facilitating computation the following table was used:

t.	$1 + (t - 89.5)\, q$.	Log.
70	0.99064	9.99592
80	0.99544	9.99802
90	1.00024	0.00010
100	1.00504	0.00218

F.° . . .	1	2	3	4	5	6	7	8	9
P.P. log.	21	42	63	84	105	125	146	167	188

Magnetic Moment during Summer of 1878.

Date.	t.	mt.	log mt.	Reduction to mean t. log $[1+(t-89.5)q]$.	log $mt\ [1+(t-89.5\ q]$ $=$ log m.	Days	d.
July 7	92.	0.7500	9.87506	0.00052	9.87558	0	− 26
" 10	91.5	0.7027	9.84675	0.00040	9.84715	3	− 23
" 11	100.	0.7350	9.86628	0.00210	9.86846	4	− 22
" 12	98.	0.7417	9.87021	0.00177	9.87198	5	− 21
" 13	99.2	0.7345	9.86600	0.00202	9.86802	6	− 20
" 17	87.	0.7511	9.87572	9.99948	9.87520	10	− 16
" 20	89.5	0.7511	9.87572	0.00000	9.87572	13	− 13
" 21	88.	0.7522	9.87635	9.99969	9.87604	14	− 12
" 22	87.5	0.7514	9.87586	9.99958	9.87544	15	− 11
" 24	94.	0.7496	9.87482	0.00094	9.87576	17	− 9
" 27	89.	0.7503	9.87522	9.99994	9.87512	20	− 6
" 31	89.5	0.7394	9.86887	0.00000	9.86887	24	− 2
Aug. 1	86.7	0.7506	9.87542	9.99942	9.87484	25	− 1
" 3	94.	0.7509	9.87558	0.00094	9.87652	27	+ 1
" 6	94.5	0.7448	9.87205	0.00104	9.87309	30	+ 4
" 14	89.6	......	9.74963	0.00002	[9.74965]	[38]	
Sept. 4	99.5	0.7505	9.87533	0.00208	9.87741	59	+ 33
" 6	71.5	0.7713	9.88724	9.99623	9.88347	61	+ 35
" 7	94.	0.7548	9.87786	0.00094	9.87880	62	+ 36
" 9	70.7	0.7527	9.87663	9.99607	9.87270	64	+ 38
Oct. 11	73.	0.7547	9.87779	9.99655	9.87434	66	+ 40
	89.5				9.87323	26	

Taking the mean of the column headed "Days," beginning with July 7th (but rejecting the observations of Aug. 14th), it is found to be 26, corresponding to Aug. 2d.

Assuming

$$\log m = \log m_0 - ad,$$

where

$d =$ number of days, estimated from Aug. 2d,

$\log m_0 =$ value of $\log m$ on Aug. 2d $= 9.87323$.

$a =$ the change in $\log m$ per day.

The observations give 20 equations of condition of the form

$$e = \log m_0 - \log m - ad,$$

from which, by the method of least squares, we find

$$a = -0.00012,$$

and hence

$$\log m = 9.87323 + 0.00012\ d.$$

The negative value of a and an inspection of the values of log. m, in the previous table, shows that further reduction would be unprofitable. It will be deferred until next year.

Reduction of Intensity Observations.

The units used were foot, grain, second.

The reductions for oscillations are indicated by the formulæ.

$$mH = \frac{\pi^2 k}{T^2}$$

$$T^2 = T'^2 \left\{ 1 + \frac{h}{f} \right\} \left\{ 1 - (t' - t)\, q \right\}$$

where t' = temperature of the oscillation series;
t = " " deflection "
$1 + \frac{h}{f}$ is the correction for torsion;
T' = observed time of oscillation;
k = moment of inertia of the magnet;
m = the magnetic moment of the oscillating magnet;
H = the horizontal intensity of terrestrial magnetism;
T = the corrected time of oscillation;
q = the constant of temperature.

For the deflection series,

$$\frac{m}{H} = \tfrac{1}{2}\, r^3 \tan u \left(1 - \frac{P}{r^2} \ \ldots\ldots\ldots\right),$$

where r = the distance between the magnets;
u = angle of deflection, corrected for torsion and temperature;
P = a constant, depending upon the distribution of magnetism in the two magnets.

At each station the mean of values log. $\frac{m}{H}$ were taken, and the mean temperature of the two series was taken as the temperature of the deflecting magnet, to which temperature the oscillation series was reduced. This is sufficiently accurate when the differences in temperature are small.

For the Canton observations, however, the following reduction was made:

Calling u and u_0 angles of deflection at temperatures t and t_0, then

$$\sin u = \frac{\sin u_0}{1 - (t_0 - t)\, q}.$$

One deflection series was thus reduced to the temperature of the other, for which temperature the oscillation series was also corrected.

Inclination.

Observations of inclination were all made with dip circle No. 9, made by Henry Barrow & Co. of London. It was provided with two needles, marked 2 and 3, each 9½ inches long, and with axles 0.021 of an inch in diameter. The agate planes on which the needles rested were ¾ of an inch apart. The circle was divided to 10′, and the readings were made by simple microscopes, which enables the reading to be estimated to single minutes with tolerable accuracy.

The horizontal circle of the instrument was four inches in diameter, divided to half degrees, and provided with a vernier reading to minutes, but with no tangent screw.

The instrument was at first set in the magnectic meridian, by taking the mean of the readings of the horizontal circle for all possible reversals, when the angle of dip was 90°, which gives its position when the plane of the ring is at right angles to the magnetic meridian. This was found to occupy too much time, and it was found afterwards as satisfactory to set the instrument by means of a good pocket compass before introducing the needle.

At one or two stations, at first, two readings were made for each position of the needle and circle, but thereafter three readings were made. This was done by gently raising the axis in the *Ys* and bringing it down upon the agate planes so as to cause very small oscillations. The polarity of the needles was always reversed just before a series, being magnetized by three strokes on each side for the first observations at any station, and by four for the subsequent reversal at that station. At Columbia, Louisiana, Canton, and Keokuk, the needles were, however, stroked only on one side, owing to a misunderstanding of the instructions.

Following is appended a description of the stations where observations were made, with an abstract of the results obtained. They bear evidence to some local attraction which is known to exist at several points, particularly in the vicinity of Wright City, in Warren Co.

A discussion of the distribution of magnetism in this State will be deferred until the completion of the survey, which will require two years, by which time the completion of a similar survey in Iowa, by Dr. G. Hinrichs, may enable us to include all under one discussion.

STATION 1—*Iowa City, Iowa.* In University campus. Lat. 41° 39 41″; Lon. 91° 31′ 30″.

STATION 2—Four miles west of Iowa City, in front of house of P. Nipher, 40 yds. distant.

[At these two stations no tent was used; the results are, therefore, not very reliable. Hinrichs gives the following values, determined under a tent: Declination 8° 24′. $H = 4.184$.]

STATION 3—*St. Charles, St. Charles Co., Mo.* Lat. 38° 45′.0; Lon. 90° 29′.8. In field on river bottom, 20 rods S.W. of depot.

STATION 4—*Wright City, Warren Co., Mo.* Lat. 38° 47′.1; Lon. 91° 00′. In orchard of Charles Bird, S.E. of depot. In this region local action is observed at many points.

STATION 5—*Mexico, Audrain Co., Mo.* Lat. 39° 11′.1; Lon. 91° 52′.1. In vacant lot at S.W. corner of Washington and Love streets.

STATION 6—*Columbia, Boone Co., Mo.* Lat. 38° 56′.5; Lon. 92° 20′.2* In University campus, on hill S.E. of spring and N. of the N.E. corner of the stone building of the University.

STATION 7—*Louisiana, Pike Co., Mo.* Lat. 39° 28′.0; Lon. 91° 06′.7. Declination and inclination with needle No. 3 at corner of Fourth and Alabama streets. All intensity observations and inclination, with needle 2, were taken in the yard of Blodgett's hotel, corner of Third and North Carolina streets.

STATION 8—*Hannibal, Marion Co., Mo.* Lat. 39° 44′.1; Lon. 91° 23′.7. On Holliday's Hill, at head of Main street, overlooking limestone quarry.

STATION 9—*Canton, Lewis Co., Mo.* Lat. 40° 08′.6; Lon. 91° 35′.6. In vacant lot two blocks S. of Down's house.

STATION 10—*Keokuk, Lee Co., Iowa.* Lat. 40° 24′.8; Lon. 91° 28′.0. In vacant lot at corner of Third and Concert streets. Wind-vane of Signal Office bears S. 7° 41′.6 W.

STATION 11—*Memphis, Scotland Co., Mo.* Lat. 40° 27′.3; Lon. 92° 13′.3. In vacant lot N. of N.W. corner of public square and opposite hotel.

* Prof. Ficklin gives the following determinations: Lat. 38° 56′ ?″; Lon. 15° 16′ 30″, from Washington.

STATION 12—*Kirksville, Adair Co., Mo.* Lat. 40° 11′.7; Lon. 92° 36′.7. On W. side of public square and S.W. of pavilion in centre.

STATION 13—*Macon City, Macon Co., Mo.* Lat. 39° 46′.4; Lon. 92° 29′.6. 100 yds. W. of North Missouri hotel.

STATION 14—*St. Louis, Mo.* Lat. 38° 38′ 03″.3; Lon. 90° 12′ 15″.3. These values refer to the old observatory at Washington University.

a. S.E. corner of Garrison av. and Dickson st., in centre of vacant square.

b. N.W. corner of Garrison and Franklin avs., near centre of square, and S.W. of Gen. Sherman's house.

c. Near centre of block bounded by Lucas place, St. Charles, 18th and 19th sts.

d. S.W. corner of Washington av. and 18th st., E. of Woman's Home, and 45 ft. from curbstone.

e. Forty-five feet S. of Station *d*.

The St. Louis values are probably all affected by local attractions.

STATION 15—*Kansas City, Jackson Co., Mo.* Lat. 39° 07′.2; Lon. 94° 37′.7. Bluff between Grand avenue and McGee street and N. of Presbyterian church.

STATION 16—*Sedalia, Pettis Co., Mo.* Lat. 38° 42′.2; Lon. 93° 15′.5. In public square, W. side. Set by happy accident exactly in axis of an accurately mounted transit which was 40 yds. S. This transit was mounted on a section of gas-main about 6 inches in diameter, which has possibly influenced our results slightly.

STATION 17—*Vinita, Indian Territory.* Lat. 36° 41′.4; Lon. 95° 07′.1. Complete determinations were made in the △ formed by the crossing of the Missouri, Kansas and Texas and the St. Louis and San Francisco railroads. From lack of transportation it was impossible to secure a better location. The distance to each track was 60 yds.

Fearing local action, magnet C_6 was oscillated 60 yds. on the opposite side of the *Y* track, but with no protecting tent. The wind interfered to some extent, but the sky was cloudy, preventing insolation.

MAGNETIC DECLINATION OR "VARIATION."

STATION.	MAGNET SCALE. Eastern Elongation.	MAGNET SCALE. Western Elongation.	MAGNET SCALE. Mean.	MAGNET SCALE. Axis reads.	MAGNET SCALE. Reduction to Axis.	AZIMUTH CIRCLE. Azimuth Circle reads.	AZIMUTH CIRCLE. Magnetic South reads.	AZIMUTH CIRCLE. True South reads.	Declination East of North.	Date.
	d.	d.	d	d.	′	° ′	° ′	° ′	° ′	
Iowa City	81.1	75.6	78.3	76.72	− 3.8	148 34.5	148 30.7	139 53.9	8 36.8	July 2
Wright City	80.1	82.5	81.3	76.70	+ 4.8*	153 22.5	153 27.3	145 13.4	8 13.6	" 12
Mexico	80.5	75.3	77.9	76.44	− 3.4	244 06.0	244 02.6	236 24.0	7 38.6	" 13
Columbia	80.1	73.8	76.95	76.68	− 0.6	166 09.7	166 09.1	158 23.8	7 45.3	" 16
"	80.3	73.5	76.9	76.72	− 0.4	166 06.2	166 05.8	"	7 42.0	" 17
Louisiana	79.3	71.9	75.6	76.40	+ 2.1	164 22.7	164 24.8	157.15.8	7 09.0	" 19
"	80.0	76.4	78.2	[76.40]	− 4.2	164 25.5	164 21.3	"	7 05.5	" 20
Hannibal	81.5	78.45	79.97	76.64	− 7.8	151 45.7	151 37.9	144 29.6	7 08.3	" 23
Canton	79.6	76.8	78.2	[76.64]	− 3.5	262 43.3	262 39.8	255 16.6	7 23.2	" 25
"	81.1	77.0	79.05	[76.64]	− 5.6	262 06.3†	262 00.7	"	6 44.1	" 26
"	79.0	70.0	74.5	[76.64]	+ 4.9	262 27.0	262 31.9	"	7 15.8	" 27
Keokuk	76.9	69.15	73.0	76.64	+ 8.2	239 31.0	239 39.2	232 05.5	7 33.7	" 29
"	77.8	69.0	73.4	[76.64]	+ 7.6	228 28.7	228 36.3	221 01.0	7 35.3	" 31
Memphis	78.9	72.3	75.6	[76.64]	+ 2.4	277 15.5	277 17.9	269 30.2	7 47.7	Aug. 2
Kirksville	79.5	73.1	76.3	76.42	+ 0.3	249 58.0	249 58.3	241 29.2	8 29.1	" 5
Macon	80.0	78.0	79.0	[76.42]	− 6.1	263 14.0	263 08.9	255 02.0	8 06.9	" 6
St. Louis, Station *a*	81.5	73.7	77.6	[76.42]	− 2.9	92 41.5	92 38.6	85 59.9	6 38.7	" 14
" "	78.5	74.5	76.5	77.21	+ 1.6	92 27.0	92 28.6	"	6 28.7	" 15
Kansas City	80.0	74.2	77.1	76.74	− 0.8	135 57.0	135 56.2	125 30.4	10 25.8	Sept. 5
"	78.9	74.2	76.5	[76.74]	+ 0.5	135 40.5	135 41.0	"	10 10.6	" 6
Sedalia	79.1	75.3	77.2	76.70	− 1.2	9 08.7	9 07.5	0 00.0	9 07.5	" 8
Vinita, Indian Territory	81.0	76.9	78.95	[76.70]	− 5.2	292 32.7	292 27.5	283 34.7	8 52.8	" 9

* Scale inverted. Scale value of $C_6 = 2'.35$.

† Probably wrong by 20′.

INTENSITY—OSCILLATIONS.

STATION.	DATE.		TEMP. t.	LOGARITHMS.							H.
				T'^2.	$1+\frac{h}{f}$	$1-(t'-t)q$	T^2.	k.	$mH=\frac{\pi^2 k}{T^2}$.	H.	
Iowa City	July	7	92°	1.72670	0.00208	9.99937	1.72815	1.22356	0.48971	0.61465	4.1177
St. Louis, Station *d*..	"	10	91.5	1.73020	0.00236	0.00042	1.73298	1.22356	0.48488	0.63809	4.3460
St. Charles	"	11	100.	1.69690	0.00201	9.99989	1.69880	1.22368	0.51918	0.65290	4.4968
Wright City	"	12	98.	1.68122	0.00183	0.00042	1.68347	1.22365	0.53448	0.66427	4.6159
Mexico.............	"	13	99.5	1.67450	0.00231	0.00051	1.67732	1.22367	0.54065	0.67465	4.7277
Columbia	"	17	87.	1.66808	0.00168	0.00303	1.67279	1.22348	0.54499	0.66927	4.6695
Louisiana	"	20	89.5	1.68110	0.00189	9.99896	1.68195	1.22352	0.53587	0.66015	4.5725
"	"	21	88.5	1.67946	0.00205	9.99917	1.68068	1.22350	0.53712	0.66077	4.5790
Hannibal..........	"	22	87.5	1.68398	0.00231	9.99983	1.68612	1.22349	0.53167	0.65581	4.5270
"	"	22	86.	1.68434	0.00231	0.00015	1.68680	1.22346	0.53096	0.65546	4.5233
Canton.............	"	24	94.7	1.69392	0.00254	9.99860	1.69506	1.22360	0.52284	0.64743	4.4405
"	"	27	89.	1.69256	0.00183	9.99979	1.69418	1.22351	0.52363	0.64783	4.4446
Keokuk	"	30	88.5	1.69834	[0.00197]	0.00045	1.70076	1.22351	0.51705	0.64324	4.3978
"	"	31	89.5	1.69970	0.00197	9.99996	1.70163	1.22352	0.51619	0.64732	4.4394
Memphis...........	Aug.	1	86.7	1.68896	0.00217	0.00028	1.69141	1.22348	0.52637	0.65095	4.4766
Kirksville	"	3	94.	1.69502	0.00226	0.00000	1.69728	1.22359	0.52061	0.64503	4.4160
Macon	"	6	94.5	1.68920*	0.00230	9.99910	1.69060	1.22360	0.52730	0.65525	4.5212
St. Louis, Station *a*.	"	14	89.7	1.67682	0.00221	9.99910	1.67813	1.22352	0.53969	0.79014	......
Kansas City	Sept.	4	99.5	1.66884	0.00206	9.99989	1.67079	1.22367	0.54718	0.67185	4.6973
"	"	6	71.5	1.66566	0.00221	0.00379	1.67161	1.22325	0.54594	0.65870	4.5572†
Sedalia.............	"	7	94.	1.66464	0.00212	9.99974	1.66650	1.22359	0.55139	0.67353	4.7155
Vinita, I. T., Sta. S.	"	9	70.7	1.62490	0.00233	0.00125	1.62848	1.22323	0.58905	0.69242	4.9252
" " " S'.	"	9	72.3	1.62342	0.00208	0.00100	1.62650	....	....	....	4.9476‡
St. Louis, Station *e*..	Oct.	11	73.	1.67530	0.00210	0.00099	1.67839	1.22327	0.53918	0.66139	4.5855

* Sign of correction for rate of watch uncertain.
† Temperature correction large, and uncertain, from sudden change.
‡ See description of this station, p. 97.

Station.	Date.		t.	r ft.	Logarithms. $\frac{d}{u}$.	$1+\frac{h}{f}$	Corrected tan u	$\frac{m}{H}$	m.	Remarks.
Iowa City	July	7	88.3	2.00	1.72738	0.00460	8.65687	9.25984	9.87566	Under tree. No tent.
"	"	8	90.	1.75	1.90200	0.00477	8.83175	9.26099		
St. Louis, Sta. d.	"	10	94.2	2.00	1.67364	0.00508	8.63352	9.20649		
	"	10	92.8	1.75	1.85132	0.00512	8.78169	9.21093	9.81679	
St. Charles	"	11	100.	2.00	1.68237	0.00472	8.61193	9.21190		
"	"	11	99.	1.75	1.85263	0.00481	8.78260	9.21184	9.86627	
Wright City	"	12	99.	2.00	1.67371	0.00418	8.60289	9.20586		
"	"	12	101.	1.75	1.84773	0.00401	8.77684	9.20608	9.87021	
Mexico	"	13	101.	2.00	1.66039	0.00464	8.58981	9.19278		
"	"	13	103.5	1.75	1.83347	0.00459	8.76317	9.19241	9.86600	
Columbia	"	17	100.5	2.00	1.67486	0.00349	8.60321	9.20618		
"	"	17	102.7	1.75	1.84888	0.00349	8.77748	9.20672	9.87572	
Louisiana	"	20	86.	2.00	1.68338	0.00385	8.61226	9.21523		
"	"	20	83.	1.75	1.85741	0.00416	8.78669	9.21593	9.87572	
Hannibal	"	22	86.	2.00	1.68798	0.00544	8.61830	9.22127		
"	"	22	87.5	1.75	1.85938	0.00566	8.78959	9.21883	9.87586	
Canton	"	24	88.	2.00	1.69767	0.00499	8.62743	9.23040		
"	"	24	93.4	1.75	1.86503	0.00498	8.79633	9.22557	9.87541	Corrected to 88°.
Keokuk	"	30	89.	2.00	1.69886	0.00453	8.62828	9.23125		
"	"	30	92.5	1.75	1.87088	[0.00453]	8.80064	9.22988	9.87381	
"	"	31	89.2	2.00	1.68677	0.00501	8.61666	9.21963		
"	"	31	90.2	1.75	1.86421	0.00479	8.79427	9.22351	9.86887	Scale value of C_1, = 2′.89.
Memphis	Aug.	1	88.	2.00	1.68802	0.00693	8.61983	9.22280		
"	"	1	88.	1.75	1.86732	0.00440	8.79691	9.22615	9.87542	
Kirksville	"	3	94.	2.00	1.69767	0.00587	8.62834	9.23131		
"	"	3	94.	1.75	1.86964	0.09577	8.80056	9.22980	9.87558	
Macon	"	6	89.	2.00	1.68473	0.00526	8.61473	9.21770		
"	"	6	91.3	1.75	1.85615	0.00541	8.78669	9.21593	9.87205	
St Louis, Station a	"	14	85.1	2.00	1.67738	0.00491	8.60713	9.21010		
" "	"	14	85.6	1.75	1.85049	0.00481	8.78045	9.20967	9.74965	
Kansas City	Sept.	4	98.9	2.00	1.67168	0.00501	8.60110	9.20407		
"	"	4	98.6	1.75	1.84357	0.00498	8.77365	9.20289	9.87533	
"	"	6	90.	2.00	1.69627	0.00472	8.62586	9.22883		
"	"	6	88.	1.75	1.86784	0.00593	8.79898	9.22822	9.88724	
Sedalia	"	7	93.4	2.00	1.67131	0.00521	8.60137	9.20434		
"	"	7	92.3	1.75	1.84463	0.00532	8.77508	9.20432	9.87786	
Vinita	"	9	78.	2.00	1.63149	0.00450	8.56083	9.16380		
"	"	9	76.	1.75	1.80581	0.00456	8.73539	9.16463	9.87663	
St. Louis, Station e	Oct.	11	77.	2.00	1.68404	0.00512	8.61412	9.21709		
" "	"	11	78.7	1.75	1.85830	0.00512	8.78649	9.21573	9.87779	

MAGNETIC INCLINATION OR DIP.

Needle No. 2.

Station.	Marked End. North.	Marked End. South.	Mean by Polarities. Series I.	Mean by Polarities. Series II	Result'g Dip.	Date. 1878.
	° ′	° ′	° ′	° ′	° ′	
St. Louis, Sta. *a*	69 05·8	69 35·0	69 18·1	69 22·6	69 20·4	May 27
" " *b*	69 10·6	69·24·1	69 21·7	69 13·0	69 17·7	" 28
" " *c*	69 08·3	69 27·5	69 22·8	69 12·9	69 17·9	" 30
Iowa City, Io. " 2	71 51·7	72 13·9	72 00·3	72 05·3	72 02·8	June 16
" " Univ.	72 12·4	72 27·0	72 13·6	72 25·7	72 19·7	July 2
St. Charles	69 11·5	69 48·4	69 23·2	69 36·2	69 29·9	" 11
Wright City...	68 57·3	69 30·1	69 06·1	69 21·3	69 13·7	" 12
Columbia	69 01·8	69 22·6	69 09·1	69 15·2	69 12·2	" 17
Louisiana	69 25·8	69 56·3	69 39·1	69 43·1	69 41·1	" 21
Hannibal	69 51·9	70 08·4	70 02·9	69 57·3	70 00·1	" 22
Canton	70 10·4	70 32·0	70 23·0	70 19·4	70 21·2	" 24
Keokuk, Iowa .	70 26·2	70 48·2	70 34·6	70 39·8	70 37·2	" 29
Memphis	70 27·4	70 32·8	70 29·7	70 30 3	70 30·0	Aug. 2
Kirksville.....	70 13·9	70 49·9	70 31·7	70 32·1	70 30·9	" 5
Macon	70 03·5	70 11·2	70 15·2	69 59·5	70 07·3	" 6
Kansas City...	68 51·9	69 15·4	69 02·3	69 05·1	69 03·6	Sept. 3
Sedalia	68 41·4	68 52·3	68 50·6	68 43·1	68 46·9	" 8
Vinita, I. T. ..	66 18·3	66 54·2	66 46·5	66 25·9	66 36·2	" 9

MAGNETIC INCLINATION OR DIP.

Needle No. 3.

Station.	Marked End. North.	Marked End. South.	Mean by Polarities. Series I.	Mean by Polarities. Series II.	Resulting Dip.	Date. 1878.
	° ′	° ′	° ′	° ′	° ′	
Wright City	69 42·5	68 58·6	69 14·2	69 26·9	69 08·8	July 12
Mexico	69 38·0	69 17·2	69 30·7	69 24·5	69 27·6	" 13
Columbia...	69 50·3	69 02·0	69 29·5	69 22·8	69 26·1	" 15
Louisiana ..	70 24·5	69 34·2	70 02·1	69 56·6	69 59·4	" 20
Hannibal ...	70 40·7	70 16·4	70 33·1	70 24·0	70 28·5	" 22
Canton	70 52·9	70 16·2	70 38·3	70 30·8	70 34·5	" 24
Keokuk.....	71 04·9	70 47·5	71 04·4	70 48·0	70 56·2	" 29
Memphis ...	70 44·9	70 02·3	70 24·2	70 23·2	70 23·6	Aug. 2
Kirksville...	70 58·5	70 42·3	70 53·5	70 47·3	70 50·4	" 5
Macon	70 25·7	69 50·2	69 56·4	69 19·1	70 07·9	" 6
Kansas City.	69 46·1	69 02·1	69 22·9	69 25·2	69 24 1	Sept. 3
Sedalia.....	69 28·8	68 36·2	69 04·3	69 00·3	69 02·5	" 8
Vinita, I. T..	66 63·9	66 21·8	66 39·0	66 46·7	66 42·8	" 9

The Tornado of April 14, 1879.

By J. L. R. Wadsworth, M.D.,* and Francis E. Nipher.

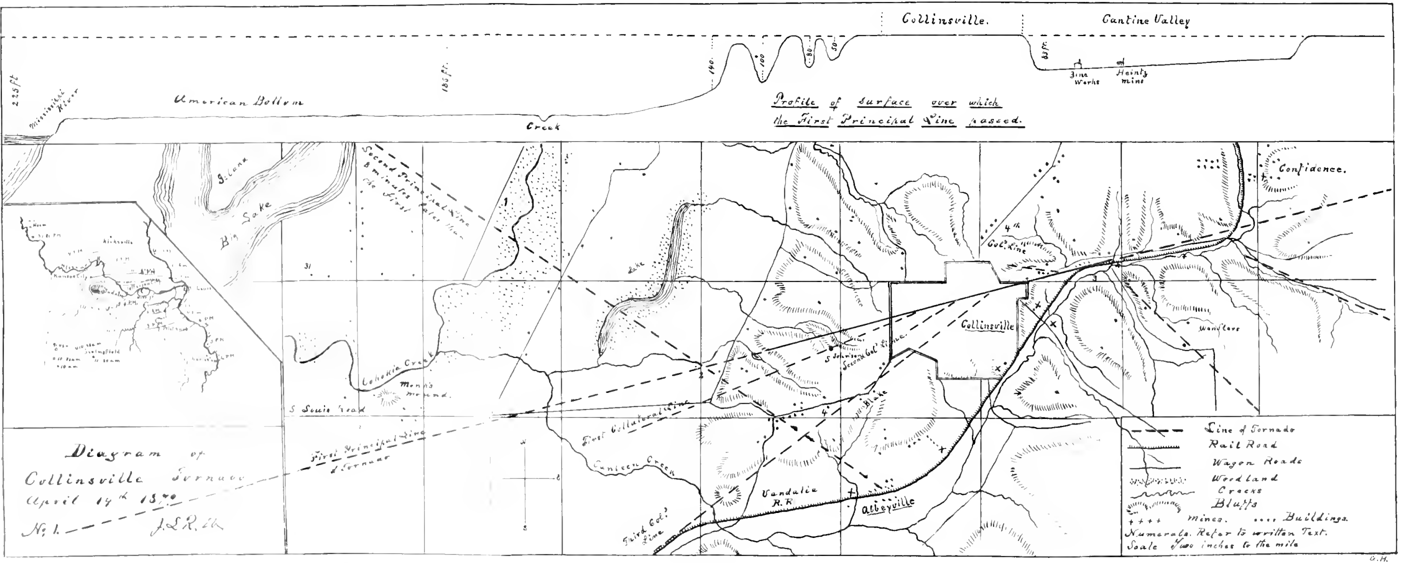
The weather map of the Signal Service, for 7 : 35 a.m. of the 14th of April, shows that a well marked barometric depression existed over southwestern Missouri, and over Indian Territory and southeastern Kansas. It was central about 60 miles N.W. of Ft. Gibson. During the day this area moved to the N.E. and at 4 : 35 p.m. it was central near Marshfield, Mo., about 170 miles S.W. of St. Louis.

Shortly after midnight of the 13th – 14th, a light rain began in the region around Glasgow, Mo. This rain area extended outward in all directions, the front of the rainstorm forming at 4 a.m. an oval or ellipsis, the major axis of which extended from a point somewhat north of Lexington to near Fulton, lying thus in the Missouri bottoms. The length of this major axis is about 150 miles. The minor axis was at the same time about 50 or 60 miles in length. The velocity with which the front of the rainstorm advanced was then about 25 to 30 miles in the direction of the major axis, and from 15 to 20 miles per hour in a direction at right angles thereto. [At the same time a rain in the Indian Territory had extended into southwest Missouri, the two rains apparently mingling in the Osage valley at about 9 a.m.] The amount of rain was on the average one-fourth of an inch, and the duration from half an hour to an hour and a quarter. It reached St. Louis at 7 a.m., where the rainfall was only a tenth of an inch. In the western part of the area the rain was heavier, being 0.8 at Kansas City.

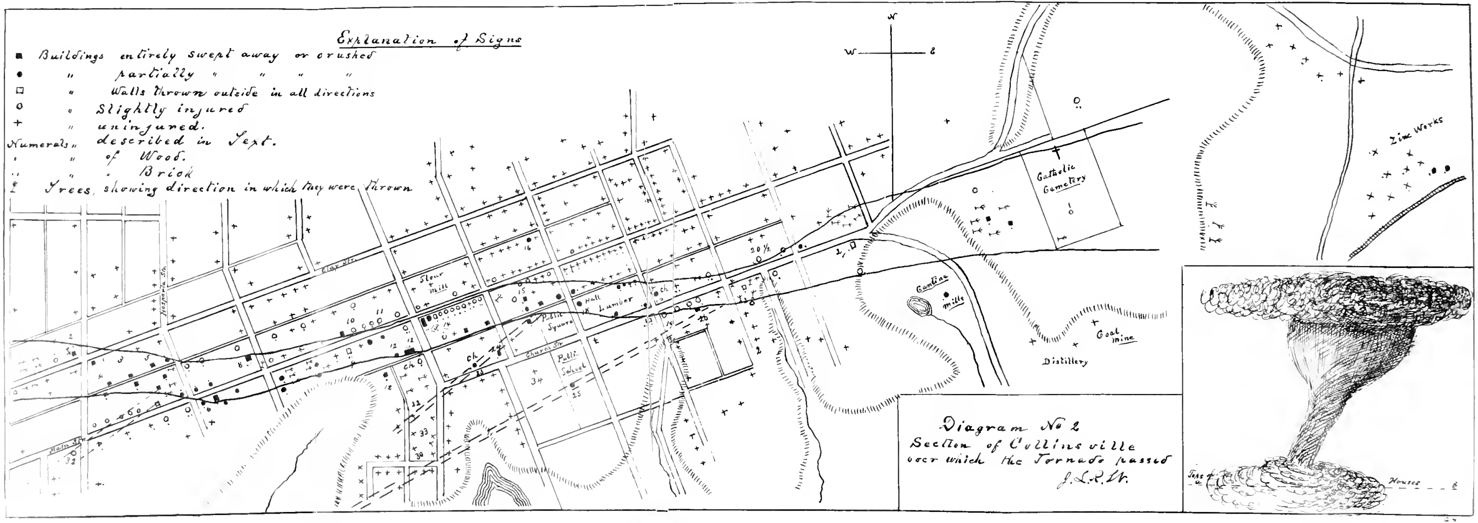
This rain thus existed first as an *area*, and was continued as a slowly enlarging belt, or *elliptical ring*, on the inside of which the rain had already ceased. This seems to indicate a descending current of air, which, striking the earth, spread thus outwards, its front being marked by a raincloud.

At noon, a rain area, precisely similar to the former, began at

* Dr. Wadsworth has collected all the information in regard to the effects of the tornado, a work which his intimate acquaintance with the witnesses has enabled him to do with great success.



Collinsville.
Cantine Valley
225 ft
Mississippi River
185 ft.
140
100
80
50
83 ft.
Zinc Works
Heintz mine
American Bottom
Creek
Profile of surface over which the First Principal Line passed.
Big Lake
Second Principal Line 8 minutes after the First Principal Line
Lake
Confidence.
4th Col. Line
Collinsville
Cahokia Creek
Monk's mound.
St. Louis road
First Collateral Line
First Principal Line of Tornado
Second Col. Line
Blake
Canteen Creek
Vandalia R.R.
Albeyville
Third Col. Line
Diagram of Collinsville Tornado April 14th 1879
No. 1.
J. L. R.
Line of Tornado
Rail Road
Wagon Roads
Woodland
Creeks
Bluffs
mines.
Buildings.
Numerals. Refer to written Text.
Scale Two inches to the mile
G.H.



Explanation of Signs
Buildings entirely swept away or crushed
" partially " " " "
" Walls thrown outside in all directions
" Slightly injured
" uninjured.
Numerals " described in Text.
" of Wood.
" " Brick
Trees, showing direction in which they were thrown
Clay Str.
Main Str.
Church Str.
Flour mill
Hall
Lumber
Public Square
Public School
Catholic Cemetery
Cantine mills
Coal mine
Distillery
Zinc Works
Houses
Diagram No 2
Section of Collinsville
over which the Tornado passed
J. L. R. W.

Chamois, 80 miles S.E. of Glasgow and about 60 miles W. of St. Louis. The major axis of this rain area was almost due east and west, extending at 1 p.m. from a point about midway between Sedalia and Warrensburgh to St. Charles. The northern boundary of the rain passed at this time near Mexico, the southern being about midway between Chamois and Rolla, in a region not represented by observers. The rainfall was in this case somewhat greater than in the morning. It was most violent at the extremities of the longitudinal axis, being 0.83 at Chamois, reaching a maximum of 2.75 at Sedalia, 100 miles west of Chamois, and increasing also rapidly to the east, being 1.92 inches at St. Louis. Farther to the east, in Illinois, the rain was also very violent, but no observations were made upon it.

The facts above given are all clearly shown by the observations of the Missouri Weather Service. The progress of the second rain is represented on a small map on Chart No. 1, which shows the time of beginning of the rain and the amount of rain in inches.*

At St. Louis the raincloud appeared in the west shortly after 1 o'clock, and at 2 p.m. heavy rain and hail with thunder and lightning began, the hailstones averaging ½ inch in diameter at Washington University. Some of the hailstones were 1½ inches in diameter. At this time the wind was from the N.W. The hail ceased at 2:10 and the rain ceased at 2:20. The wind in the mean time had for a short time reached 40 miles per hour: it quickly subsided to 10 or 15 miles per hour. At 2:20 the clouds overhead appeared much broken, the surface wind and lower cloud (scud) moving from the N.W., while the upper clouds came from the S.E. Although broken overhead, a smooth and somewhat luminous raincloud was coming rapidly up from the west; its front was of a green color: it had the appearance of being a thin cloud, through which the sunlight was transmitted in unusual quantity. At 2:35 heavy rain and hail again began, the hail being somewhat smaller than before, but in greater quantity. At

* It is hoped that this will be sufficient to show all of our observers how important it may be to determine accurately the times of beginning and ending of all rains, even when they appear to be insignificant. It should also be stated whether the time given is St. Louis, Chicago, Jefferson City, or *local* time, in order that corrections for differences of time may be made with more accuracy than has been possible in case of the ones given above.

2:42 the hail again ceased, and at 2:50 p.m. the rain ceased, the total rain and hail having been 1.92 inches.

For the history of the storm after passing St. Louis, the following report by Dr. Wadsworth is presented. The manner in which the facts were investigated by him makes his statements worthy of implicit confidence — a confidence which has been heightened in my own case by a visit to the scene of disaster in his company. Even the historic order in which the facts were brought out is of interest, and at my request this has been given somewhat in detail.

F. E. Nipher, *Sec'ty St. Louis Academy of Science.*

Dear Sir: — I enclose herewith the result of my investigation of the Collinsville tornado, which occurred April 14, 1879. Before entering upon this subject, allow me to suggest that it must be borne in mind, that this phenomenon came upon our people without warning, and passed before their vision with a probable speed of more than a mile a minute. The impression thus made would necessarily be far from complete. Of those in or near the path of the tornado, one would observe the lower, another a higher portion, very few noticing just the same features. It came to some with the shock of an explosion, or (as occurred with the writer), if they were so fortunate as to have it lift as it passed over them, they might see that a lumber-yard was being poured down upon them, which would be equivalent to not seeing the real cause at all, only a secondary result. To others, again, personal preservation was the first law of nature—(we might have said mental pertubation, for it rarely occurred that any act followed the impression until all danger was passed). To those to the north or south, or some distance in advance, and so fortunate as to have their attention properly directed, are we most indebted for what little history of this tornado we have been able to gather, otherwise than that to be obtained from the study of the destruction it left behind it.

It will readily be seen how varied must be the effect of these impressions upon the people, be they ever so astute as observers; and it has been a most interesting study, second only to the event itself, to note these peculiarities. To illustrate: one of our most clear-headed and observant citizens, perceiving the approach of the storm, although some blocks distant, ran from a very dangerous position, and found himself only across the street, holding on to a loose stump, when the tornado passed over him. Afterwards, while detailing the predicament he was found in, a bystander called attention to a large tree which had just escaped falling upon him: looking at it for moment, he quaintly remarked, "*I never knew that tree fell there.*"

We regret that these conditions have prevented us from obtaining those exact data so desirable for the investigation of this as yet mysterious application of force.

Before entering upon the history of the storm, let us notice the topography of this section so far as is necessary for a proper understanding of the subject.

Collinsville is situated 10½ miles from the Mississippi river, on a line due east of the northern part of the city of St. Louis, on elevated ground 225 feet above the river, and about one mile east of the high bluffs which form the eastern border of the American Bottom. Owing to the height of these bluffs (185 ft. above the valley,) all the little rivulets and creeks have cut deep ravines or valleys in their course to the great valley below, producing a very broken surface along and for a mile or so back of these bluffs. (See diagram 1 with profile of surface.) The valley (Am. Bottom) is about 40 ft. above the river at low water. Passing up and out of the great valley in a N.E. direction, just bordering the little city of Collinsville (3,000 population) on the E. is the Canteen creek, hemmed in with steep high bluffs, at the commencement 150 ft., and 3 miles above, to the E. of Collinsville, 83 ft. in height. Through this narrow valley of the Canteen, taking advantage of its grade, the Vandalia railroad escapes from the valley below. Here are located many coal mines, also zinc works.

Our personal observations of April 14th are as follows. Clouds and sunshine; the clouds of cumulus changing towards noon to the cumulo-stratus form, and hanging quite low to the W.N.W., apparently making slow progress. Returned home at 12:30 from the country, was anxious to remove some shrubs before the storm reached us, but was compelled to desist on account of the peculiar exhaustion experienced from physical exertion. Air very warm and sultry; heard occasional mutterings of distant thunder. 2 p.m.—The clouds look very dark and threatening: passed into my house, which has few openings to the west, so did not observe their appearance after this time, and became very much absorbed in reading. At 2:35, St. Louis time* (definitely known), I was aroused by an exclamation from Mrs. W., and simultaneously our help cried out, "The mill has blown up!" (referring to a planing-mill in a lumber-yard on the block west of us). We immediately sprang to the window (open south) and saw lumber, shingles, great sections of wooden sidewalk, limbs of trees, flying through the air; and so very thick did the air seem to be filled, that it was impossible to see across the street. Rushing to the door, the air was still filled with fine débris of leaves, pieces of old shingle, bark and twigs, borne along with a strong wind accompanied by a little rain. Passing out to the street, it was absolutely impossible for vehicles and very difficult for pedestrians to clamber over the great piles of rubbish, composed of trees, fences, wooden walks, lumber, &c. For three-fourths of a mile down the main street of our little town lay the work of this terrific force. After traversing this distance, we returned to extend the examination in the other direction, and not until we had passed our first starting-point two blocks did the return current coming from the north reach us, bearing a tremendous storm of hail and rain, accompanied by a terrific electrical display. Would judge the storm continued unabated for 45 minutes.

Finally, as the result of not far from one minute's work, we find in Collinsville 109 buildings more or less injured (24 entirely, 25 partially swept away or crushed, and 60 slightly injured), and involving the loss of one human life and seven wounded. Such is a brief view of the tornado. Although severely felt by those who suffered by it, yet, in comparison with many others that have occurred in this and adjoining States, this exhibited much less force and was followed by much less loss of life and property.

Let us now consider more closely this phenomenon. At the request of Mr. J. H. Weber, of the U. S. Signal Service, we undertook to look into a few questions, and, as we progressed, became so interested we could not lay the work aside. In order to explain the difficulties in the way of this investigation, we will at the risk, we fear, of being considered prolix, detail the manner in which one interesting question was solved — Where did the

* Indianapolis time 2:57.

tornado come from? We had followed its path through town; it seemed to be a belt about 200 ft. wide, bearing a little north of east. Had interviewed Mr. Wm. Friend, who stated that he, in company with Messrs. Courtney and McKinney, was hunting near the woods along the Cahokia creek (see 1 Diag. 1) and observed the clouds were moving in all directions, some of a dark green color, others white as steam; while discussing these peculiarities they heard a roaring noise, just above the tree tops and a little below them, in the creek, and saw a balloon-looking cloud flying rapidly to the S.E., and remarked that there would be trouble where that went.

Mrs. J. W. Peers stated that she was looking out of a second-story window to the S.W. of her residence (No. 2 Diag. 2 Collinsville) and saw a funnel-shaped cloud of a dark color approaching from the S.W. over Mr. Gaskil's house in Germantown (see No. 30, D. 2) above the tops of the houses, and in a direct line with the school building, and immediately recognized its great danger. Impressed with the fact that her son was in that building, she stood spell-bound as it quickly passed over it, and, leaving the tower still standing, felt the building was safe. She noticed as it passed over that it became of inky blackness. (It had scattered one of the large ventilating shafts down to the roof, and the soot was the cause of the change in color.)

Now here was a confusion difficult to understand. The course through town was a little north of east. Mr. Friend's evidence placed it S.E., while Mrs. Peers sent it to N.E. Determined to solve this problem, we commenced a survey of the line of the approach to the bluffs at Mr. Sumner's farm (see No. 2, D. 1), and found it had continued in the same direction as through town. Here we interviewed Mr. Alonzo Sumner, who stated as follows: "Was standing beside a barn at the foot of the bluff, in company with Mr. Nash, and observed the strange action of the clouds over the valley, and almost immediately heard a great roaring noise like a train of cars, and observed a cloud in the shape of a cone, with the small end far to the front, coming over the woods near the lake to the N.W.; it was very white, like a fog. Just then another barn below us turned over, in which were a number of colored refugees hallooing for help. The ground was covered for some minutes with clouds so densely, that one could with difficulty remove the inmates of the barn. I have the impression that when these clouds struck the ground they bursted as it were, or divided; the main portion, however, passed on in the same direction to the S.E. The barn had simply been overturned, but not scattered."

In comparing this statement with that of the hunters we had no doubt but that it was the same vortex they had seen, and, as the evidences were as plain over the bluff to Collinsville, almost E. instead of S.E., as Mr. S. had been impressed, we supposed there must be an angle made at this point. We now sought to determine the route E. of Collinsville, and found ample evidence of its course over the Catholic cemetery and down in the Canteen valley to zinc works, which it had unroofed (see D. 1, No. 3), and learned that it had now made another angle and passed to the S.E. in the Wendler neighborhood (see D. 1). Hearing that a large amount of débris had been found beyond Confidence (D. 1, extreme right), we left this trace of the storm and visited that region. Here we were surprised at the quantities of shingles, weatherboarding, clothing, &c., scattered all over the country.

Here we found Mr. Thos. Evans, who resides east of Confidence, on elevated ground, where he could have a good view of the scene. He stated that he saw a great smoke over Collinsville that he supposed at first was a fire and called the attention of his family, when almost immediately he heard a very loud noise and saw a dark mass approaching at great speed, high over the tree tops. As it passed, saw that it was composed of trees (of which he recognized two medium sized), branches, boards, and fine stuff; and then the shingles and other small débris began to settle down like snow to the ground. This débris was whirling round and round and going higher. This evidence determined us that whatever went to the Wendler neighborhood, the vortex that had destroyed Collinsville had certainly passed over this region near Confidence, for here were wagon-loads of shingles, old and new weatherboarding (painted), and other débris, that surely belonged to Collinsville. This point gained, and the fact that a direct line had been traced to the bluffs, five miles distant, a little to the south of west, the logical conclusion fastened itself upon my mind that this line *did not end there.*

With this thought in view we returned again to the foot of the bluffs and requested Mr. Sumner to restate his impressions, which he did, and very clearly impressed us that he was not mistaken as to his observation of the storm. Not being reconciled to this angle, we determined to look for further evidence towards St. Louis on this line, and continued our investigation to the west, and found to our great satisfaction, through Mr. N. Scanland (who is teaching school some five miles west of the bluff, on the St. Louis road, near Indian lake), the trace we desired. He states that while in school, about 2 : 30 o'clock, suddenly the schoolroom became so dark that not one of his scholars could see, and at the same time a roaring was heard that he thought for a moment was a distant railroad train (railroad only a little south of him), but was so loud as quickly to undeceive him. The whole school (26) were startled, but before they could look it had passed over.

Near by lives Mr. Baptiste Ganard, who stated that he "distinctly saw a large round-shaped cloud south of the schoolhouse, and that it made a great noise and was moving east above the tops of the trees." He did not see any débris in it.

August Stavener (see D. 1, No. 31), living two miles east and one north of this point, heard a great noise on the other side of the creek (he lives on the opposite side of the Cahokia creek, which is bordered with timber), but did not see anything, as he was occupied with the disturbances among the clouds to the northeast, in the region where our hunters had made their observation.

Mr. L. Heck was near Monk's Mound, and saw the clouds tumbling over and over (just south of the road) and making a great noise that alarmed him very much.

We now came back to Mr. Sumner's and inquired if there were any other persons that had observed the storm, and found that Mr. Kelley and another man had been plowing in a field a quarter of a mile below the barn that had been overturned. (We had not explained the difficulties that we had encountered here to anyone.)

Mr. K. said that he had seen the whole thing; that while plowing he noticed the strange action of the clouds, and saw a cloud *rolling* on the ground rapidly towards him coming from the southwest. (He had in the meantime started for the barn with his team.) As it came to him, it swung his team around in the direction it was going, and he felt the force very strongly. He thinks he was at the outer border of it. It passed on to the barn near by and turned it over; and that it was some minutes later (about eight, he thinks) the clouds came from over the little lake from the northeast, whirling rapidly, and struck the ground a few rods distant, and scattered in all directions, but still leaving the ground covered with white steamy-looking clouds that prevented one from seeing any distance.

This cleared in a great measure the difficulties of evidence here. We still made no explanation until the next day, when, in company with Mr. Weber, we went over the matter again and explained to them the difficulty we had had to reconcile their evidence. There had evidently been two vortices that passed over this point, varying a little in time. This now established the track of the tornado in a straight line for the distance of ten miles.

Meantime we had learned that Mrs. John Blake had had a full view of the storm, and we called on her (her residence is at No. 4, D. 1), and learned that she was sitting at an east window, and, hearing an unusual noise, looked out and saw in the street near the house a whirlwind as tall as the trees, of dark purplish color, making a roaring sound, and, moving rapidly towards Mr. W. J. Matthews' house, just escaping the corner of it, took a direct course for Germantown (southern part of Collinsville). Mr. W. J. Matthews did not see it, but states his house was shaken, and the cellar doors opened, and that two trees in a little orchard near the house were taken. Upon noticing this line, the rear part of the school building came right into the centre of the field; and now with Mrs. Blake's eyes to take it to Germantown, and Mrs. J. W. Peers' to trace it from there over the school building, we were enabled to say that there was more than one tornado that day; and to Mrs. Peers and Mrs. Blake, that they had not seen the tornado that had made most of the destruction.

We pass now to some other considerations respecting *First Principal Line.*

Mr. H. R. Johnson (residing at No. 5, D. 1, half a mile west of Collinsville) states that "about 1 p.m. I went out to work and noticed a peculiar look to the clouds; heard a little thunder a long distance off. A green-looking cloud—that I said to the boys with me meant hail—moved very fast over the valley from over the southern part of the city (St. Louis) to the northeast; more clouds, not looking so green, seemed to be forming, and, closing up, covered the sky, following more slowly. The southern edge of it was distinct and seemed to rest over the southern part of the city, and came out a little north of east over the south part of Collinsville. Under this cloud a large number of little thunder-heads, some very dark, others as white as steam, came pouring in from the northwest; they seemed to be separated and running low, very low. I never saw clouds so low before. Pretty soon they began to go in all directions, some up, some down, right and left, backwards and forwards. I went to the house, for I knew there was going to be trouble. I next saw a cloud that looked even all over in color and very white, the edges pretty even. I noticed it because it moved so steadily: it seemed to be right under the edge of the cloud from the southwest that I spoke of, and right between me and St. Louis. It seemed to be coming right along and directly towards me. I at once went in and closed three windows and two doors; then I heard the roaring, and stepped out again. It had reached the bluff and was coming over it. I wanted to see which way it was going before I did anything." (Mr. J. was in the East St. Louis tornado and had just escaped being caught in that.) "It looked now like a great, huge balloon-shaped cloud, and very dark. I saw it was going north of me (about 40 rods). It went by at great speed, not more than one minute from the bluff to Collinsville (one mile). At the bluff it seemed to bound up and down; at Collinsville it hugged the ground closely. It was full of small stuff, taking here and there a tree, but throwing it out at once. There was no lightning or thunder until sometime after: a few large drops of rain came just before it. While this whirlwind was over Collinsville, I also noticed another and smaller whirlwind to the south of the main one, but did not see it pass. My house was shaken by wind, which seemed to play around the roof, but at the surface of the ground the wind was very feeble. The impression made on me was that the house was being lifted."

It is interesting to observe, that, in this part of its path, more damage was done in the bottoms of the deep ravines (shown in the profile of Diagram 1) than on the ridges between them. In the first ravine from the west, a dozen trees were broken off, while on the bluffs comparatively little damage was done. The next ravine was part of Mr. Johnson's garden. Some boxes, weighing several pounds each, were lifted from the bottom of this ravine, some being carried about 300 feet in the line of the storm, while one was carried about 200 feet to the west. In the third ravine, several rods of fence were thrown down towards the west.

Mrs. Willie, of Pleasant Ridge, 4½ miles due north, stated that she "stood on her porch and saw the top line of the tornado as it passed over Collinsville. It passed like a railroad train, and was so low—I never saw the clouds so low down before. The top of it seemed to pop up and down." This motion of the tornado she indicated by placing her hands together, dropping them suddenly, and rapidly raising them to their first position. "It moved very fast, and was gone right away," was her expression. We were enabled to get a very clear idea from this lady as to its height above a belt of timber half a mile away, and from this data we determined the altitude to be about 500 feet: this has been the nearest approach we have been enabled to secure of the height of the vortex.

Mr. Geo. Matthews, living some three to four miles northeast, noticed the low clouds over Collinsville. "Two clouds from opposite directions seemed to meet, and passed still lower"; saw black smoke above it in a peculiar shape, and still above this saw objects—he could not tell what they were—which looked about the size of a board; but acknowledged that he could hardly see an object so small at that distance. The objects were *coming down*; he was sure he did not see them go up. Heard no thunder and saw no lightning. He spoke of the air presenting a very peculiar appearance; seemed to be in different shaded strata and quite marked.

Mrs. Lanham lives two miles northeast; "saw heavy clouds over Collinsville which seemed to come from the northwest, and were lower than those already over, and moving more rapidly; one, of a dark green color, seemed to be whirling, shaping itself in a bulbous form. At the bottom of the slim portion, just above the tops of the houses, a hazy appearance rose up, and through this

I saw roofs come up whirling. No lightning or thunder for 20 or 30 minutes afterwards; then a terrific hailstorm. The roaring resembled a railroad train, such as we hear on damp mornings, when the sound is very clear and loud. My sister, Mrs. Mudge, of Saline, was with me, and as soon it passed we each took our pencils and sketched our impressions of the appearance of the cloud, to compare and see if our impressions were the same." We take pleasure in presenting the sketch by Mrs. Lanham (the other was lost). The two sketches were as near alike as one person would be likely to make two successive sketches.* (See Diag. 2.)

Mr. P. J. Bergin, engineer at Hintz's mines, one mile east of Collinsville, directly on line with the tornado and at the point where it left the surface, stated: "I noticed the clouds because they were so heavy and acted so strangely. Two clouds came together, one from the S.W., the other from the N.W.; these last were the highest. They were all over the American bottom; the clouds from the S.W. were the heaviest and looked the worst." We failed to get a clear idea of his description of the appearance of the atmosphere, which he thought was exceedingly strange and interesting. The word "irridescent" would perhaps express most nearly my understanding of his meaning. "They made me think there was trouble ahead, and I closed the blinds and doors of the engine-house. The roar and noise commenced before I had finished, and I ran outside as it came over into the Canteen valley to the zinc works. Here it spread out about six hundred feet as black as night." (Large quantities of coal cinders from these works are spread over considerable surface here and were readily carried up, hence blackness.) "The air was full of plank and cinders, and I got down to my little sapling; the pressure as it passed over was great, but it lasted but a moment, and was too high overhead to do any damage. Could hardly say where the tornado went to, but the clouds seemed to rise up higher. No lightning, I think, but a little rain."

The *First Collateral Line* commenced in the great valley scattering in its course a large stack of hay, tearing away trees, and

* In the original sketch the shading was uniform, and there was no representation of spiral motion. This part has been supplied by the lithographer. F. E. N.

entered Collinsville a few feet south of Main street (western terminus). C. Krapf lives at this point (No. 32, D. 2) and was at work in his yard; heard it coming and saw the clouds whirling very low, almost touched his house; took his chimneys, some of his fence, and hot-bed sash; moved along Main street, doing no damage, save most effectually clearing out the chimneys on the north side of the street, and joined the *Principal Line* at Main and Hesperia streets. This tornado passed high in air, but its track is marked by trees broken off half way down; these were distinctly marked near Johnson's (5 on Diag. 1), and it was evident that the tornado had passed directly over his house. (Compare statement of Mr. Johnson's previously given.)—*Second Collateral Line*, observed by Mrs. Listerman (No. 33, D. 2). This vortex was smaller, not higher than a medium tree, and moved along Church street. She saw it take the Methodist church and the new portion of Mr. Lawrence's house, and join the principal line. Its motion was very rapid.—*Third Collateral Line* has been previously described by Mrs. Peers and Mrs. Blake. It extended into the valley near the Vandalia railroad, where it tore down a few telegraph poles. From this point to Collinsville, this tornado passed over the tops of the trees and buildings, doing very little damage. But for the witnesses who saw it, and who did not see the main tornado, it would have been impossible to trace its path.—*The Fourth Collateral Line* was noticed by Mr. Joseph Lumagi, and did very slight damage, removing a stack of hay and scattering it so evenly that Mrs. Thompson describes the appearance "as if a mosquito net had been spread out over the sky." It joined the main line at the zinc works. —*The Fifth Collateral passed away* from the principal line at Hintz's mine, and its track has been followed one and a half miles. It destroyed trees, fences, and a barn, and carried off two straw stacks, of which no trace of the last has yet been found. We include Mr. John Wendler's statement: "I was not well and had laid down; was called by my wife, who thought there was going to be a severe storm, the clouds were so very strange. When I reached the door, saw an immense balloon-looking cloud, very dark and black at the top and white below; it was about over the bluffs, full three miles west; it came very fast, and I saw it was turning around at the top. There was so much black smoke over Collinsville that I thought there was a fire. From the time I first saw it until it passed me, do not think it was over *two or three minutes*." Mr. W. is located on a high elevation and could judge clearly as to position. He appears not to have seen the part which passed directly on high in air towards Confidence. It was however seen by other persons in the vicinity of Confidence. —*Sixth Collateral Line* also passed away from principal line at the railroad crossing near Confidence, and, running E.S.E., carrying trees, fences, and scattering a straw stack over one mile; whole line traversed, two miles; observed by Messrs. Jules Maury, Charles Flick, and L. Hinckey. The principal vortex, after leaving the surface at Hintz's mine, is traced as such, still bearing large quantities of débris, even trees, two miles eastward, where we lose all sight or trace of it. Here it blends with the general storm, which reached Highland (18 miles E.N.E.) about 3:30, as indicated and carefully noted by Mr. A. Œhler, whose interesting letter we copy.

"*Highland, Ills.*

"Your letter in reference to the storm of the 14th, referred to me by my friend and colaborer Mr. Ad. F. Bandalin. Allow me to begin with the following table of the day:

Date.	7 A.M.			9 A.M.			12 A.M.			2 P.M.			4 P.M.			9 P.M.		
April	Therm.	Wind.	Weather.	Therm.	Wind.	Weather.	Therm.	Wind.	Weather.	Therm.	Wind.	Weather.	Therm.	Wind.	Weather.	Therm.	Wind.	Weather.
14	56	SE	Cloudy	63	SE	Cloudy	7:	SE	Clear	62	ESE	Cloudy	55	NNW	Rain	54	N	Cloudy

The readings of the Thermometer in the above are after Fahrenheit."

The directions from which the wind came are given.

"A little after 2 p.m. the sky presented a calm, cloudy appearance, the characteristic short gusts of wind beginning to manifest themselves; about 2:50 a very gentle sprinkle, which soon ceased; wind E.S.E., clouds a little thicker and darker. My attention was now attracted to a pretty large, strange, livid-looking, solitary cloud, of a cumulo-stratus nature, just above the N.E. horizon. Just at this time (3:15) I was called away for about five minutes, when lo! on my return, it had almost disappeared, and the wind was veering N., settling in the N.N.W., from whence it blew during the whole of the storm. The whole western and north-eastern sky had become dark, and presented a very threatening aspect. Now came the gale with a few claps of thunder, accompanied by lightning and very little rain, followed by more or less of a calm of about 25 or 30 minutes' duration; then gusts of rain, hail the size of hazel-nuts, with much electrical disturbance, lasting, I should judge, about 50 minutes. From all I could find out, I feel confident there were no vortices formed in this neighborhood."

It was also observed at Lebanon, 12 miles E.S.E., by Prof. E. E. Edwards, of McKendree College, from whose letter we quote:

"Dear Doctor:—Your card was received. After reading Prof. Nipher's report in the *Globe-Democrat*, I thought of writing and furnishing all the points from my standpoint. I give the diary entry, entered 'Monday evening, Apr. 14. Two o'clock, evidence of a cyclone to the N.W. Mercury fell in barometer about half inch rapidly. Faculty meeting from 1 till 3 p.m.; after which, went down stairs to hear class (which recites at 2:50). Then noted barometer. Very dark, could hardly see figures on blackboard; considerable hail. At 3:40 the storm seemed at its worst: had botany class for a few minutes, and then dismissed and hurried home, reaching home before the rain commenced. Prof. Deneen dismissed his classes through apprehension.'

"I will add recollections: From 2:30 to 3:30, a dark blue-black cloud, apparently charged with electricity, overhung one-third of the heavens N.W. of us. I knew it was a tornado, and was much distressed, as I had reason to think my wife was on the train that passed Collinsville about that time. She describes it as terrific beyond conception or description.

"Mrs. E. gives these particulars of the tornado as it appeared from Highland: — As the train left Greenville, there appeared forward and to the right of the train a dense black cloud with a purple or bluish tinge. Nearing Highland, the aspect of the nearer clouds was changed; they seemed charged with livid light, and across which played the most vivid and incessant lightning. To the right beyond, the clouds were low-hanging and of inky blackness. The rain commenced before reaching Highland, and reached its maximum this side near St. Jacobs, and then it commenced to hail. Between St. Jacobs and Collinsville the track was flooded with water, telegraph poles down, and cars tangled in the wires. Near Collinsville, detached broken clouds swept rapidly through the tree tops, and apparently against the tops of the cars."

We now return to consider more clearly the effects of these vortices in Collinsville, for here it is, by a singular coincidence, they all concentrated. Commencing with the principal line where it entered town (Diag. 2), the first point is at 1—A light wagon picked up and whirled around, the shafts broken off; direction of motion opposite the motion of the hands of a watch, with the face up. At 2, 1½-story dwelling crushed but not scattered, débris inclined in direction of storm; seven trees in this block lay in line of the storm, one south and one out-building north. 3. Building at the corner scattered, the next thrown several feet in line of storm. 4. A trench excavated by the vortex, 12 ft. long, 20 in. deep, also in line. 5. A barn, that has never been found; several trees all in line. 6. Double 1½-story frame dwelling lifted six feet high and set down angling upon the foundation, as evidenced by the cellar stairs, attached to the floor of the house, which were carried over a partition wall in the cellar and not broken off. 7. A similar building utterly crushed and scattered; here a life was lost and two persons wounded. 8. A 2-story double brick—the front part had its walls thrown outward, but not scattered; here was evidenced a peculiar application of force not unlike explosion; trees N. and N.W. 9. A 1-story brick dwelling, solidly built, with whole of north front thrown outward, while the roof remained in place, and the house was otherwise uninjured. 10. An interesting example: a one-story frame dwelling had to be entirely rebuilt; it was found literally shaken apart, but not entirely separated, excepting the porch, which was thrown down; outside walls all bulged outward; the plastering all shaken off; roof had shingles all loosened, but not taken off. 11. Three-story brick, with half a dozen bricks taken out just under the coping of the cornice, and nothing else disturbed. 12, 12, 12. All brick dwellings, showing some evidence of explosion, but scattered and more or less swept away from the premises. 13. One-story brick exploded; this was more marked than any other (see special reference further on). 14. One-story frame, the same. 15. A sign carried westward; very few instances where débris was taken in this direction. 16. Roof, the same. 17. A single light of glass in a show-window burst inward by a jet of wind only large enough to cover this light of glass, and this occurred on the east side of the building. 18. A large one-story frame hall and reading room, 60×75, moved off its foundation, and not especially injured. 19. Several articles removed from porch on south side of building inclosed on three sides, open only to the south, and taken to the north of the house. 20. Here all the trees and sidewalks carried north; house frame exploded on east side; a small plank penetrated a heavy brick wall in second story of 20½, D. 2. 21. A one-story frame with the *east* wall pulled off some 18 inches, some glass bursted outwards, and no other injury involved; chimneys secure.

First Collateral Line, already described.

Second Collateral Line, the same.

Third Collateral Line, after passing school building, passed lower; it probably produced that dextrous little effect at 19. At 26, utterly crushed and scattered a small building, near this point closing in to the principal line, at which point there was an unusual change given to the course of trees and débris generally.

Fourth, Fifth and Sixth Collateral Lines, previously described.

We have only enumerated peculiar phases or conditions, and made no attempt to describe the damage inflicted. A general idea can be had by reference to the Diagram of Collinsville, No. 2. Among the many singular incidents we select a few only.

At Mr. Cox's, just west of town, after tearing away part of his barn and some 15 trees, it raised the roof of his dwelling (1½-story) at the eaves, and snatched a pair of pants, a shaving and a soap box, and deposited them on the hood of an awning that projected over his front door, the roof settling back nearly to its place again.

We have a piece of cornstalk, 3 inches long by ¾ inch wide, that had been driven through the hard, painted surface of an old door ¾ of an inch.

At a blacksmith shop, north side of Main street, lay the bed of a light wagon, the running gears being in the second story of a wagon shop, on the south side of street, that was utterly crushed and scattered (some 300 feet distant), and where they were being painted. After the storm they were found to the east, *side by side, and uninjured.*

A horse and buggy, standing in front of a church in which a funeral was being conducted, was taken up into the air and whirled 260 feet distant, and dashed to the ground, killing the horse and but slightly injuring the buggy. Some by-standers claimed that this horse and buggy were carried fifty feet high.

In block 13 and 14 there was a two-story brick business block, covered with a tin roof, the rafters and sheeting of which were carried across the street, while the tin was found spread out upon the upper joists, a few inches lower than its usual position. The explanation probably is that a first gust of wind tore the tin loose and tumbled it up on one side; a second was sufficient to remove the sheeting and rafters without reaching to the tin rolled up on one side; while a third current threw it back into the last position named.

On the west front of Temperance Hall are a number of nails driven to various depths head first.

On the west end (facing the storm) of the office in a lumber yard, small pine splinters, smaller than pipe-stems, are driven into the siding.

The next building east of 19 was pierced in two places through its walls by rafters from some of the destroyed buildings in the other end of town.

Two of my neighbors (Messrs. Miller and Patton) had purchased a property and divided it. On the division line there stood an out-kitchen. Just before the storm they were devising means to dispose of it, neither desiring to take it. A moment later there was a decision from the supreme court: the building was torn to pieces and scattered, while the two-story house was only shaken up severely.

Very many other instances of singular escape and coincidence occurred, but they have no special bearing on our subject.

According to your own published reports, the storm reached St. Louis at 2 o'clock p.m. Continuing from this point, we find it pursued an even course with the same velocity, reaching Collinsville, 10½ miles east, at 2:35; Lebanon, 21 miles east, at 3:00; and Highland, 29 miles east, at 3:30 (St. Louis time). It would seem that the necessary elementary conditions for the development of the tornado were found over the American Bottom, and that this development was purely local and did not extend much over ten miles, and had no apparent influence upon the general storm that was passing at a higher altitude to the eastward. That it consisted of a principal vortex, of very considerable power, accompanied by six collateral vortices, of much less power, that seemed to *possess more than an incidental relationship to the principal:* and a second principal vortex apparently independent in time and direction. That the direction of the principal vortex was 15° north of east, and, while there was a probable swaying to the one side or the other, the paths of the vortices were in straight lines. It will be noticed that the first four collateral vortices are *convergent* upon the path of the principal vortex, and that the two last are *divergent*. That the principal vortex was in contact with the surface while it was receiving the first four, and that it had left the surface before it gave off the last two collateral vortices. The height of the principal vortex was about 500 feet, the collateral were comparatively small. The rotary spiral motion was in the direction opposed to the movement of the hands of a watch and of great velocity. The progressive motion was about one mile a minute. It had also a vertical or lifting motion, which was often quite abrupt (and proved the most interesting part about it to the writer, for by this motion he escaped destruction). The path was narrow on the approach to Collinsville, about 100 feet, gradually widening, and the vortex at the same time exhibiting less force. At the zinc works it was 600 feet wide. Its lifting power was sufficient to carry large roofs at least 600 feet high; this, with a power equal to the momentum of a body moving sixty miles an hour, would carry heavy débris some distance. The effect of these motions was to break up every object it carried up with it; even lumber, taken up free from all contact with any thing else, would come down, in many instances, in kindling wood.

An interesting phenomenon in connection with the tornado, and covering a large proportion of the destruction attending it, comes from a peculiar "explosive action."* To illustrate: a one-story brick building (as at 13, D. 2), protected on the west, 20 ft. distant, by a tall substantially built brick block; on the east, 20 inches, a one-story frame; and 15 ft. from the last a two-story brick. Now the vortex struck the brick block on the west, tearing off the roof and the west wall down to the second floor: then, rising and inclining upwards, it took the brick partition and the east wall, the latter extending nearly to the top of the second story; next passing over 13 & 14 (the one-story building), but striking the next brick building, and cutting off the fire-wall above the roof. The line of destruction was evenly and plainly marked, and the débris was scattered (some of it) a long distance. This line was above 13 & 14, and yet what was the result? At 13, the east wall leaned over at the top, resting against the west wall of 14, 20 inches distant; the northwest and south walls lay on the ground, as if they had been evenly pushed over outwards, the roof attached to the upper joists in their normal relation; the east end of these joists rested on the wall that leaned against the next building, and the west end rested on the floor, which had not been moved; no part or portion had been carried away; the furniture and clothing all left and not scattered; two persons under the leaning joists and roof uninjured. No. 14, built of wood, had the gables burst outward, but again there was no scattering.

In about thirty minutes after the vortex had passed, there was a return current from the north, bearing a very severe hail and rain storm, accompanied by a most terrific electrical display. There was no electrical disturbance—as would be indicated by lightning and thunder—connected, in any manner, with the vortices.

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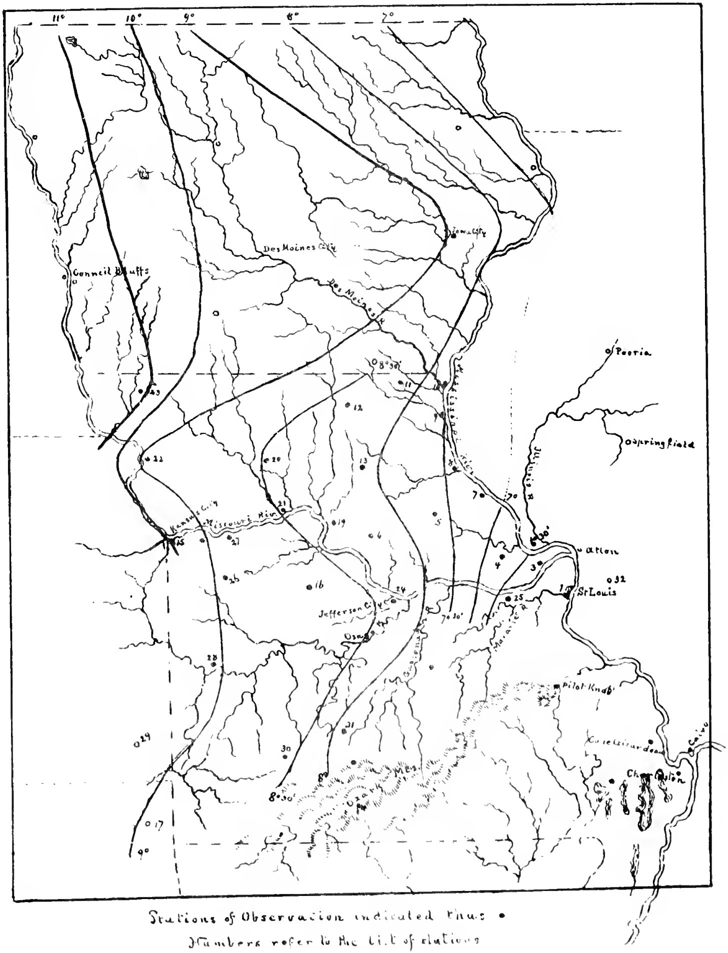
* This is sometimes attributed to rarefaction of air outside of the house, the unbalanced internal pressure throwing the walls outward. To say, under the conditions which obtain in a tornado, that there is a tendency to rarefaction at the centre of the vortex, is equivalent to the statement that the wind is blowing.

In case of a vortex approaching a building, the inrushing wind would cause a great pressure on the windward side of the house, and the pressure on the lee side would be less. The breaking of a window on the windward side would transmit the pressure to the interior. The support of the side walls would cause the lee wall to be most vulnerable. The side walls might also be started outwards, and the reverse winds, after the tornado has passed, would tend to throw the remaining walls outwards. The violence of the wind would, of course, determine the distance to which the ruins would be scattered.

F. E. N.

Magnetic Declination in Iowa and Missouri
From Surveys by
G. Hinrichs and F. E. Nipher.



Stations of Observation indicated thus •
Numbers refer to the list of stations

Report on Magnetic Determinations in Missouri, Summer of 1879.*

By Francis E. Nipher, Professor of Physics
in Washington University.

The magnetic survey of Missouri, begun during 1878, was continued during the summer of 1879.

The instruments used were the same as in 1878, except that a new collimator magnet (marked No. 1), made at the University work-shop, was used for declination determinations, and a magnetometer was also constructed in order that declination and intensity determinations might be made at the same time. In fitting up this magnetometer, the deflection bar of the Coast Survey instrument $D._3$ was used, and an excellent transit was loaned by Blattner & Adam, instrument makers, St. Louis.

I also take pleasure in acknowledging financial aid from the following named persons: Wayman Crow, John T. Davis, Wm. G. Eliot, Wm. A. Hargadine, Edwin Harrison, Henry Hitchcock, Chester H. Krum, Geo. E. Leighton, Wm. H. Pulsifer, Jno. R. Shepley, E. C. Simmons, James E. Yeatman.

The following named railroads furnished free transportation to all points upon their roads: Missouri Pacific; St. Louis and San Francisco; St. Louis, Kansas City, and Northern; Missouri, Kansas, and Texas.

But for the generous aid and coöperation which has thus been extended, it would have been impossible to have continued the work.

I was accompanied by Mr. Julius W. Shaub, a student of Washington University, whose skill and care in experimenting have contributed greatly to the value of the work.

In some cases where the determinations of 1878 were thought to be unsatisfactory, the work was repeated during 1879.

Following is a description of the stations where observations were made during 1879. The numbers are continued from the previous report.

Station 18 *a*—*Iowa City, Iowa.* In yard of Dr. Morsman, 10 yds. W. and 22 yds. S. of the S.W. corner of house. Meridian from polaris

* Read October 6th, 1879.

observations. My observations within the city limits have been unaccountably discordant; those made at Stations *b* and *c* were highly satisfactory.

STATION 18 *b*—*near Iowa City*. Farm of P. Nipher, 17 yds. S. and 11 yds. E. of the S.E. corner of the house. University dome bears N. 64° 50′.1 E., being distant 19,300 ft.

STATION 18 *c*—In meadow of P. Nipher, 90 yds. E. of the N.W. corner of the house. At these stations, *b* and *c*, independent meridian determinations were made by polaris observations.

STATION 19—*Glasgow, Howard Co., Mo.* Lat. 39° 13′.3; Lon. 92° 49′.6. At the intersection of Howard and Fifth sts. Polaris observation spoiled by clouds. Meridian determined by equal altitudes of sun. No gas pipes in Glasgow.

STATION 20—*Chillicothe, Livingston Co., Mo.* Lat. 39° 47′.4; Lon. 93° 34′.5. In meadow 65 yds. S. of house of Sydney McWilliams.* Spire of public school building bears S. 16° 19′.8 W. Polaris observation.

STATION 21 — *Carrollton, Carroll Co., Mo.* Lat. 39° 21′.1; Lon. 93° 32′.8. Yard of Wm. Eads; 27 yds. W. and 35 yds. S. of the S.W. corner of his house. After two unsuccessful attempts, a clear night gave a fine polaris observation.

STATION 15—*Kansas City, Mo.* The same as Station 15 of 1878. While the observations of this year were being made, 4-inch gas mains were being put into the street to the north, and distant about 60 yds. Too far away to do harm. Meridian by equal altitudes of the sun.

STATION 22—*St. Joseph, Buchanan Co., Mo.* Lat. 39° 45′.6; Lon. 94° 49′.2. About a mile from the river and in yard of Jas. F. Barnard, 45 yds. N. of the house, and 13 yds. from front fence. A 1½-inch gas main 40 yds. W., and a single lamp post 50 yds. to the S.W., are too far away to do harm. No other pipes near. Meridian by polaris observation.

STATION 23 *a*—*Maryville, Nodaway Co., Mo.* Lat. 40° 21′.0; Lon. 94° 57′.5. In park of the Valley House, about 8 yds. from the N. and W. fences. The track of the K. C. & C. B. Ry. lay 100 yds. E. Passing locomotives weighing 30 tons did not appreciably influence the needle. After making the observations, 20 tons of railroad iron were discovered lying 120 yds. due east. To guard against local influence, observations were made at the two stations below. Polaris observation for meridian.

STATION 23 *b*—*Maryville.* On prairie 120 yds. N.W. of Station *a*. Meridian obtained from Station *a* by triangle formed by the mark and the two stations.

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* The gentlemen who kindly gave us the use of their grounds for observation, will receive a copy of this report as an expression of thanks.

STATION 23 *c*—*Maryville.* On prairie 225 yds. N.W. of Station *a* and 325 yds. from the track. Meridian deduced from Station *a*.

STATION 16 *b*—*Sedalia, Pettis Co., Mo.* Lat. 38° 42′.$_2$; Lon. 93° 15′.$_5$ The meridian observations were made in the yard of Mr. A. D. Jaynes, all magnetic observations being made in a vacant square to the S. and owned by E. J. Payn; observations midway between Ninth st. and the alley, and on the W. side of the lot. The nearest piping is a 12-inch water main, with a 4-inch gas main on Ohio st., one block E. of the instruments. The observations of 1878 were made within 25 ft. of this main, and were certainly influenced by it.

STATION 24 *a*—*Jefferson City, Cole Co., Mo.* Lat. 38° 34′.$_8$; Lon. 92° 09′.$_0$. Observations in State-house yard, on the terrace below the general level of the yard. Track of the Mo. Pacific Ry. 100 yds. N.E.; centre of State-house front 67 yds. N.W. No influence from locomotives and trains, although the trial was made with the needles free and damped with glycerine, and with the train running slowly, and at full speed, as well as when standing to the N.E. One train thus tried contained six cars loaded with railroad iron. Due E. 115 yds. was a foundry and machine shop, which was not discovered until after the observations were begun, although inquiry was made for such causes of disturbance. The owner of the foundry estimated the total amount of iron about his place at 20 to 30 tons. It is, therefore, quite certain that the foundry was far enough away, nevertheless its proximity is to be regretted. The State-house is heated by stoves, and contains no iron. Polaris observation for meridian. Intensity was determined by an oscillation series, the number of oscillations being observed by Mr. Chas. F. Jorden, time being taken by myself, owing to the temporary absence of Mr. Shaub.

STATION 24 *b*—*Jefferson City.* 66 yds. S.W. of the State-house, nearly in line with its front, and 83 yds. from the centre of the Arsenal, which contains 5 tons of iron. Polaris observation and complete intensity determination were made here.

STATION 24 *c*—*Jefferson City.* Observations made on a sand-bar in the middle of the river and half a mile above the State-house. The intensity was determined by a careful oscillation series, the magnetic meridian by a single reading of needle No. 1 at 8:30 o'clock A.M., and the true meridian by the triangle formed by the mark and Stations *b* and *c*. The uncertainty of this declination is certainly not over 7′, and is probably less.

STATION 24 *d*—*Jefferson City.* A little less than a mile from the State-house, in the peach orchard of Philip Chappell. Centre of State-house dome bears N. 4° 31′.$_9$ E Complete determinations made here, the meridian being determined by polaris observations.

STATION 25—*Washington, Franklin Co.* Lat. 38° 31′.$_2$; Lon. 90° 58′.$_9$

In orchard of Dr. E. McLean, to the N.E. of the house, 105 yds. from the track of the M. P. R.R. and 135 yds. from the river. Polaris observation for meridian. The declination being much less than was expected, it was re-determined at four stations around the primary station and about 40 yds. distant, the meridian being deduced from the observations at the primary station. The magnetic meridian at these stations was determined approximately by a single observation at an observed time of day. These observations showed differences not greater than 5′ from the mean of all which differed about 1′ from the mean of two complete determinations made at the primary station. Hence no local influence present. The importance of making the Jefferson City and Washington determinations beyond all doubt was felt while on the ground, and will be appreciated on inspection of the chart of declinations.

STATION 26 *a—Holden, Johnson Co., Mo.* Lat. 38° 37′.8; Lon. 94° 03′.0. Observations on the common 125 yds. N. of the depot. Two observations on polaris for meridian. In the observation for Aug. 11, the upper tangent screw was used by mistake in adjusting on the mark, thus destroying the first mark reading. The weights of the two observations were taken as 1 and 2.

STATION 26 *b*. 140 yds W. of the former station. Meridian deduced from observations at Station *a*.

STATION 27 *a—Lexington, Lafayette Co., Mo.* Lat. 39° 11′.5; Lon. 93° 52′.9. On the "show block" to the E. of town. Polaris observation for meridian. The declination determination differing half a degree from a determination which others had made in the court-house yard, observations were made at

STATION 27 *b*, which is ½ mile distant to the N.W. from the former station. Polaris observations were also made here. These observations were made in the yard of the Methodist Female College, 54 yds. S.W. of the S.W. corner of the building. Their agreement with the observations of Station *a* was very satisfactory.

STATION 28 — *Schell City, Vernon Co., Mo.* Lat. 38° 02′.6; Lon. 94° 04.′6. On the prairie E. of town. Meridian determined by equal altitudes of the sun.

STATION 29—*Parsons, Labette Co., Ks.* Lat. 37° 20′.0; Lon. 95° 17′.4. Observations on the common near the house of A. Wilson, and 70 yds. from the centre of the street in front of the "East-side School-house." Polaris observations were made in Mr. Wilson's yard.

STATION 30 — *Springfield, Greene Co., Mo.* Lat. 37° 15.′6; Lon. 93° 14.′6. Station 84 yds. a little W. of N. of the N.W. corner of Drury College, in a pasture field. Meridian by polaris observations made in the yard of Drury College.

STATION 31—*Lebanon, Laclede Co., Mo.* Lat. 37° 48'.0; Lon. 92° 42'. On the commons to the S.E. and in front of the Laclede Hotel, and 150 yds. from the R.R. track. An observation on *polaris* was made from the piazza of the hotel, no evening mark reading having been taken, and a second observation was made in the yard of Josiah McKnight. These determinations differed 3', and the weights of the two were taken at 1 and 3, respectively. In the absence of Mr. Shaub, I received very satisfactory assistance from Master William Diffenderffer.

STATION 14 *e*—*St. Louis.* On the grounds of Wm. Glasgow, cor. Glasgow place and Garrison av.; 31 yds. to the Sheridan av. fence and 59 yds. to the centre of Garrison av. It was afterwards learned that a water main 3 or 4 ft. in diameter runs up the centre of Garrison av. As Station *a* of last year and Station *e* are equidistant from this main, and on opposite sides, the mean for the two stations will give the most reliable value for declination, which is 6° 23.'5. Polaris obs. for meridian.

STATION 32—*Collinsville, Madison Co., Ills.* About 9 miles from Washington University, and a little N. of E. Observations made in the yard of Dr. J. L. R. Wadsworth, a few feet E. of the centre of the yard. No gas pipes in the city and location favorable. Polaris observation for meridian. At the two stations last named, Mr. E. A. Engler acted as assistant.

DECLINATION.

Declinometer No. 3 of the Coast Survey was used.

The new magnet, "No. 1," was used for all determinations after July 11. Its axis was re-determined at nearly all stations, and was found quite constant. The scale value of one division of this magnet is $1.'_{902}$. Some excellent silk furnished by the Nonotuck Silk Company of Florence, Mass., was sufficiently strong, so that a single (combined) fibre would carry the magnet. This greatly simplified the determination of the torsion correction, rendering it much more constant, and reducing its value to a minimum.

The determinations were all made outside of the tent, and, in order to protect against wind, a closely fitting hood of heavy muslin was drawn around the magnet-house. The transit was also kept covered by a cloth.

The meridian determinations were, in three cases, made by the method of equal altitudes of the sun. In all other cases, the reading of true north was obtained by taking the reading of the pole star when at its greatest eastern elongation, subtracting the azimuth of the elongation as given in the following table:

Azimuth of Pole Star at elongation from 1878 to 1888.

Year.	Lat. 32.	Lat. 34.	Lat. 36.	Lat. 38.	Lat. 40.	Lat. 42.	Lat. 44.
1878...	1° 35′	1° 37¼	1° 39½	1° 42¼	1° 45¼	1° 48½	1° 52′
1879...	34½	36¾	39¼	41¾	44¾	48	51½
1880...	34¼	36½	38¾	41½	44¼	47½	51
1881...	33¾	36	38½	41	44	47	50¾
1882...	33½	35¾	38	40½	43½	46¾	50¼
1883...	33	35¼	37½	40¼	43	46¼	49¾
1884...	32¾	35	37¼	39¾	42¾	45¾	49¼
1885...	32¼	34½	36¾	39½	42¼	45½	49
1886...	32	34	36½	39	41¾	45	48½
1887...	31½	33¾	36	38½	41½	44½	48
1888...	31¼	33¼	35¾	38¼	41	44	47½

This table is calculated for the first of July of each year, and is taken from a table prepared at the U. S. Coast Survey Office.

The following table, from the same source, gives the time of elongation of the pole star from April, 1878, to April, 1888, and between the latitudes 26° and 50° N., with an error of less than five minutes. The time is local astronomical time.

Eastern Elongations.

Day of Month.	April.	May.	June.	July.	August.	Sept'r.
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
1	18 37	16 39	14 37	12 39	10 37	8 36
7	18 14	16 16	14 14	12 16	10 14	8 12
13	17 50	15 52	13 50	11 52	9 50	7 48
19	17 26	15 28	13 26	11 29	9 27	7 25
25	17 03	15 05	13 03	11 05	9 03	7 01

Western Elongations.

Day of Month.	October.	November.	December.	January.	February.	March.
1	18 27	16 25	14 28	12 26	10 24	8 30
7	18 04	16 02	14 04	12 02	10 00	8 06
13	17 40	15 38	13 40	11 39	9 35	7 43
19	17 17	15 15	13 17	11 15	9 13	7 19
25	16 53	14 51	12 53	10 51	8 49	6 55

The reductions and results of the declination work are given in a table at the close of this report, and the lines of equal declination are also represented in a chart. No further discussion is necessary until the completion of the survey.

Just prior to engaging in the work of 1879, and while engaged in selecting brass for a new magnetometer, it was discovered that the central (north) leveling screw of Declinometer No. 3 was strongly magnetic, and that the side screws in the magnet box were also magnetic, although in a less degree. It required 60 milligrammes of iron when equidistant to counteract the attraction of the lower end of the leveling screw, which evidently contains a small mass of iron. The correction which this necessitates in the intensity work of 1878 will be discussed further on.

Great difficulty was found in obtaining brass sufficiently free from iron, and it was finally found necessary to obtain selected specimens of copper and zinc and make a special cast. Even this brass was not pure, and although the screws introduced in Declinometer No. 3 (viz., the front leveling screw and two side screws) were more nearly pure than the old ones, the corrections have not been reduced, the effect having been to change the *direction* of the resultant couple. I am also led to suspect that brass may be contaminated by contact with steel tools, although experiments on this point have not given concordant results, and further attention must be given to it.

The full extent of this defect was not discovered until the close of the work of 1879, as the pressure of other work prevented me from giving it the attention which it should have received.

In order to determine the uncertainty thus introduced into our determination of declination, the deflections produced by the four screws used during 1878 were carefully measured for all of the 24 possible arrangements. The errors are

Greatest possible error, $\pm\ 2'$.
Probable error,* $\pm\ 0.'2$.

The two new screws used in 1879 were always kept on the same side of the box, although they may have been transferred from one side to the other during the summer. This reduces the number of possible arrangements to 8, and the errors were found to be for 1879—

Greatest possible error, $\pm\ 2.'$
Probable error, $\pm\ 0.'2$.

The uncertainty therefore lies inside the ordinary limits of accuracy in declination work, and the relative errors are even less, as it was always the custom—to which there were, perhaps, two or

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* That is, half of the errors are numerically less than $0.'2$, the rest being between $\pm\ 0.'2$ and $\pm\ 2.'0$.

three exceptions—to retain the same arrangement of screws. This is further evidenced by the satisfactory agreement of observations repeated at the same place. The precautions necessary for the elimination of these errors are sufficiently evident.

HORIZONTAL INTENSITY.

All determinations were made under a tent, which was so arranged that the wind could always be prevented from striking the instrument.

The determinations at Iowa City were made with Declinometer No. 3 of the Coast Survey, and magnets C_6 and C_{17}. All subsequent work was done with a new magnetometer belonging to Washington University. Magnets C_6 and C_{17} with the old stirrup were, however, used for this work.

At each station an oscillation series was made with C_6. The experiments were conducted substantially as in 1878. The oscillations were called by myself, and Mr. Shaub noted the time by means of the watch (Jürgensen 10890). In this way it was found we could estimate tenths of a second with considerable precision. It is scarcely necessary to say that all precautions were taken to secure an unbiassed reading of the watch.

The following will serve as a specimen determination:

Jefferson City, Aug. 12.

Oscillations.	Time.	Time of 100 Oscillations.
	H. M. S.	
0	9 13 41.5	
10	9 14 49.7	
20	9 15 58.0	
30	9 17 06.2	
40	9 18 14.3	
50	9 19 22.6	
		M. S.
100	9 25 04.0	11 22.5
110	9 26 12.2	11 22.5
120	9 27 20.7	11 22.7
130	9 28 29.0	11 22.8
140	9 29 37.0	11 22.7
150	9 30 45.2	11 22.6
	Mean,	11 22.63

Observed time of 100 oscillations, . . .	$682^s.63$
Time of one oscillation, ...	$6\ .8263$
Correction for rate, ...	$0\ .0003$
$T' =$	$6\ .3260$

The correction for the rate of the watch is one-fifth of the correction for a change of temperature of 1° F., and hence has been omitted in the reduction of all the work.

The watch was compared several times during the summer, and was found to run very uniformly, losing 3^s per day. It was allowed to run down two days before returning to St Louis, and hence no comparison could be made at the close of the work. When lying face upward, as in making observations, it was found to gain $4^s.1$ per day.

The temperature corrections and moment of inertia as function of temperature have been used in the present reduction as determined in 1878. (See pp. 87 & 90.)

Two deflection series were made at each station, the distances (r) between the deflecting and the suspended magnets being 1.75 ft. and 2.00 ft. In the latitude of Iowa City, the suspended magnet was deflected to the limit of its scale when the two magnets were 1.75 ft. apart. The deflection bar was only 4 ft. in length, so that while the values of r are perhaps not the best, they were the best that could be chosen under the circumstances.

The values P deduced from the deflection series of each station are given in a table following (see next page).

The formula for the calculation is given in the former report, p. 90.

The indiscriminate mean of these values (P) is -0.00232.

By the application of Peirce's criterion, the values for July 5th and September 13th (the first and last of the series) are rejected: hence the final value of P becomes

$$P = +0.0105.$$

Probable error of mean, ± 0.0061.

The special values of the factor $\left(1 - \frac{P}{r^2}\right)$ become

$$\log. \left(-1 \frac{P}{(2)^2} \right) =. 9.99887$$

$$\log. \left(1 - \frac{P}{(1.75)^2} \right) = 9.99851$$

VALUE OF P FOR SUMMER OF 1879.

Date.	LOGARITHMS.							P.
	$r^3 \tan u$.	$r'^3 \tan u'$.	$r \tan u$.	$r \tan u'$.	Num.	Denom.	P.	
July 5	9.55613	9.55613	8.95752	9.07006	7.45788+	8.42862—	9.02926—	—0.1070
7	9.55618	9.55401	8.95412	9.06794	7.25527+	8.43056—	8.82471—	—0.0668
21	9.51254	9.51539	8.91048	9.02932	7.33041—	8.40341—	8.92200+	+0.0836
25	9.51577	9.51587	8.91371	9.02980	5.90309—	8.40002—	7.50307+	+0.0032
28	9.50360	9.50320	8.90154	9.01713	6.46240+	8.38579—	8.07661—	—0.0243
29	9.49223	9.49317	8.89017	9.00710	6.82608—	8.38021—	8.44587+	+0.0379
31	9.50144	9.50157	8.89938	9.01550	5.95424—	8.38579—	7.56845+	+0.0037
Aug. 3	9.51731	9.51729	8.91525	9.03122	5.30103+	8.40106—	6.89997—	—0.0008
8	9.48860	9.49098	8.88654	9.00491	7.22789—	8.38256—	8.84533+	+0.0700
11	9.49276	9.49312	8.89070	9.00705	6.41497—	8.37822—	8.03675+	+0.0109
12	9.49550	9.49578	8.89344	9.00971	6.30103—	8.38057—	7.92046+	+0.0083
15	9.49763	9.49780	8.89557	9.01173	6.07918—	8.38220—	7.69698+	+0.0050
17	9.48680	9.48680	8.88474	9.00073	....	....	....	0.0000
21	9.49921	9.49914	8.89715	9.01307	5.69897+	8.38259—	7.31638—	—0.0021
25	8.48208	9.48108	8.88002	8.99501	6.84510+	8.36167—	8.48343—	—0.0304
26	9.46533	9.46475	8.86327	8.97868	6.56229+	8.34670—	8.21559—	—0.0164
29	9.46187	9.46284	8.85981	8.97677	6.81291—	8.34982—	8.46309+	+0.0290
30	9.47230	9.47207	8.87024	8.98600	6.20412+	8.35518—	7.84894—	—0.0071
Sept. 8	9.50342	9.50633	8.90136	9.02026	7.33041—	8.39950—	8.93091—	+0.0353
13	9.51189	9.50777	8.90983	9.02170	7.48686+	8.37791—	9.10895—	—0.1285

which values have been used in the reduction of the deflection series.

In reducing the magnetic moment to the mean temperature of the series, a mistake was made in the former report (p. 93) in using the temperatures of the oscillation series; that of the deflection series, to which the values had been reduced, should of course have been used. Making the proper correction, the magnetic moment of C_6, at the mean temperature of $90._8$ for the summer of 1878, is represented by the formula

$$\log.\ m = 9._{87402} + 0._{000064}\, d,$$

where d represents the number of days, estimated from Aug. 3d. The general remarks made upon this result are therefore still applicable.

During 1879 the intensity magnet seems to have been in a more satisfactory condition than in 1878. The change (a) in the value of log. m being assumed constant, we have

$$\log.\ m = \log.\ m_0 - ad\,.$$

Here m = the magnetic moment on days of observation being reduced to the mean temperature $84._5$.

m_0 = the same for Aug. 10.

d = the time in days, estimated from Aug. 10.

Putting $\log.\ m_0 - \log.\ m = y$, the residuals take the form

$$e = y - ad\,.$$

The most probable value of a, as deduced from the 22 observations, is

$$a = + \frac{[yd]}{[d^2]}$$

The calculations are given in the adjoining table.

For reducing the observations to the mean temperature 84.5, the following formula was used:

$$\log.\ m = \log.\ m_t\,[1 + (t - 84._5)\, q]\,,$$

where q (the temperature constant) is $0._{00048}$, as determined in 1878. From this formula the following table was calculated, and was used in the reductions:

CHANGE OF MAGNETIC MOMENT OF MAGNET C_6 FOR 1879.

DATE.	t.	LOGARITHMS. m_t	$1+(t-84.5)q$	m.	DAYS.	d.	v (5th place)	yd.	d^2.
July 6	85.3	9.86875	0.00017	9.86892	0	−35	+ 108	− 3780	1225
7	85.3	9.86814	0.00017	9.86831	1	34	+ 169	− 2746	1156
21	88.6	9.87212	0.00086	9.87298	15	20	− 298	+ 5990	400
25	88.6	9.86924	0.00088	9.87012	19	16	− 12	+ 192	256
28	82.9	9.87133	9.99967	9.87100	22	13	− 100	+ 1300	169
29	86.2	9.87003	0.00035	9.87038	23	12	− 38	+ 456	144
31	94.8	9.86726	0.00216	9.86942	25	10	+ 58	− 580	100
Aug. 2	80.4	9.87197	0.99914	9.87111	27	8	− 111	+ 880	64
3	80.4	9.87223	9 99914	9.87137	28	7	− 137	+ 959	49
8	82.4	9.86989	9.99956	9.86945	33	− 2	+ 55	− 110	4
11	84.1	9.87015	9.99992	9.87007	36	+ 1	− 7	− 7	1
11	84.1	9.87039	9.99992	9.87031	36	1	− 31	− 31	1
12	77.2	9.87157	9.99849	9.87009	37	2	− 9	− 18	4
15	74.1	9.87181	9.99785	9.86966	40	5	+ 34	+ 170	25
17	87.0	9.87001	0.00052	9.87053	42	7	− 53	− 371	49
21	86.5	9.87037	0.00042	9.87079	46	11	− 79	− 869	121
25	89.6	9.86928	0.00107	9.87035	50	15	− 35	− 525	225
26	92.6	9.86854	0.00170	9.87024	51	16	− 24	− 384	256
29	87.9	9.86888	0.00071	9.86959	54	19	+ 41	+ 779	361
30	95.1	9.86715	0.00222	9.86937	55	20	+ 63	+ 1260	400
Sept. 8	64.2	9.87241	9.99574	9.86815	64	29	+ 185	+ 5365	841
13	81.6	9.86837	9.99940	9.86777	69	+34	+ 223	+ 7582	1156
Means..	84.5			9.87000 = log. m_0	35		Sums ..	+0.14482	7007

t	Logs. $1+(t-84.5)q$
60	9.99486
70	9.99699
80	9.99906
90	0.00115
100	0.00322

t.	$P.P.$ log.
1	21
2	42
3	63
4	84
5	105
6	125
7	146
8	167
9	188

Hence the values

$$\log. m_0 = 9{\cdot}87000$$

$$a = + \frac{[yd]}{[d^2]} = \frac{0{\cdot}14482}{7007} = + 0{\cdot}000020$$

and

$$\log. m = 9{\cdot}87000 - 0{\cdot}000020\, d\,.$$

In order to determine the corrections to be applied to the determinations of intensity in 1878 and 1879, in order to eliminate the effect of the magnetic brass-work of the instruments, the following experiments were made in the physical laboratory of the University.

1. Declinometer No. 3 was relieved of all brass connected with it, and magnet C_6 was oscillated to determine the value of mH, the value m being assumed constant. The scale was illuminated by the reflection of the northern sky from a distant plane mirror. All iron in the room was, of course, left undisturbed.

The laboratory being on the third floor, the vibrations of the building made it impossible to secure as good results as might be desired, and the lack of time for systematic work made it impossible to conduct the experiments elsewhere.

2. The same magnet was oscillated in the magnetometers of 1878 and 1879.

Each determination was corrected for torsion, and was reduced to the mean temperature of the series.

In the following tables,

H = the corrected value, or the intensity of the field when uninfluenced by the brass-work.

H' = the horizontal intensity with the magnetometer of 1878.

H'' = the same with the instrument of 1879.

A preliminary determination made October 25th gave the following result:

$$\log. mH = 0{\cdot}51016\,, \quad \log. mH' = 0{\cdot}50903\,;$$

hence

$$H = (1 + 0{\cdot}0026)\, H'\,.$$

It became necessary to make some changes which altered the value of H, and on November 10th a new series was begun.

In the following table (n) are numbers which indicate the order in which the determinations were made. As will be observed, they were so arranged as to detect any change in the value of H during the series.

			Decl. No. 3, U. S. C. S.			University Magnetom.		
DATE.	mH.	n.	DATE.	mH'.	n.	DATE.	mH''.	n.
Nov. 12	3.419	5	Nov. 14	3.401	8	Nov. 10	3.444	1
13	3.417	6	15	3.406	9	"	3.435	2
14	3.415	7	"	3.406	11	11	3.444	3
16	3.413	14	16	3 403	12	"	3.439	4
"	3.413	15	"	3.409	13	15	3.435	10
"	3.414	16						
Means..	3.415			3 405			3.439	

Hence for the correction of the series of 1878,*

$$H = (1 + 0.0029)\ H' ;$$

and for the values of 1879,

$$H = (1 - 0.0070)\ H'' .$$

In 1879, at Iowa City, Decl. No. 3 of the Coast Survey was used, with the new leveling screw. A similar series with the instrument thus arranged gave on November 17,

	mH'''.
	3.389
	3.384
	3.388
Mean,	3.387

Hence, $$H = (1 + 0.0076)\ H''' .$$

It will be observed that while the lower end of the north leveling screw of D. No. 3 is much more strongly magnetic than any other part of the brass-work, nevertheless its effect as a whole is less than that of the two south screws. Hence the replacing of the original north screw by a purer one has increased the numerical value of the correction. These corrected values of H will all be tabulated at the close of the final report in 1880.

Inclination.

The determinations were made with the instrument described in the former report, and in the same manner.

* This vol. p. 99.

Declination.

The following tables give the calculations for the work of the summer. In most cases the mark reading in the first table is the mean of readings taken in the evening before the observation, and in the morning after the observation. The reading of the two verniers are always taken, the degrees being always from A.

The azimuth of the mark, as given in the 7th column, is estimated from the S. and from the station where the star observation was made. In the last column, the azimuth from the declination station is given. This is deduced from the previous azimuth by determining at each station the angle between the mark and the other station. These angles were repeated five times. This plan was adopted in order to get a morning reading of the mark. It was, of course, necessary to make the star observations at some point where the transit could be left in safety, and such points were not always suitable for magnetic determinations.

The following is a reduction of the three observations on the sun :

Station.	Date.	No. of Obs	Mean Time of Series. A.M.	Mean Time of Series. P.M.	t.	½ $(A+A')$	e.
			H. M. S.	H. M. S.			
Glasgow......	July 21	7	8 30 44	4 07 33	57° 15'.5	90°30'.5	±0'.1
Kansas City ..	" 29	8	9 29 07	3 16 18	43 31 .0	132 37 .5	±0. 1—
Schell City ...	Aug. 25	5	9 09 54	3 18 00	46 08	148 39 .1	±0. 1+

Station.	Date.	a.c.log.cos φ	Cor.	South.	Mark.	Az. of Mark.
Glasgow......	July 21	0.11087	+2.9	90° 33'.4	180° 00'.2	89°26'.8 W.
Kansas City ..	" 29	0.11024	+3.2	132 40 .7	179 16 .4	46 35 .7 W.
Schell City ...	Aug. 25	0.10372	+2.4	148 41 .5	180 00 .5	31 19 .0 W.

In the table, t represents half the sidereal interval between the morning and afternoon series, and ½ $(A + A')$ is the uncorrected reading of south. Treating this quantity as constant, the probable error of the mean of the n observations is given in column e. The correction due to the change of solar declination is given in a succeeding column.

The formula by which this reduction is made is given in the former report. (See p. 83.)*

* See Chauvenet, Pract. Ast. I., p. 432.

POLARIS OBSERVATIONS FOR MERIDIAN.

STATION.	Date.	Azimuth Circle. Mark reads.	Vernier A. Polaris reads.	Azimuth of Elongation	North reads.	Azimuth of Mark, Star Station.	Azimuth of Mark. Decl. Station
Iowa City, *a*	June 30	218° 24′.2	360° 01′.0	1° 47.′5	358° 13′.5	40° 10.7 W.	40° 10′.7
" *b*	July 2	180 00.4	116 40.5	1 47.5	114 53.0	114 52.6 E.	114 52.6 }
" "	" 5	179 58.9	116 40.5	1 47.5	114 53.0	114 54.1 E.	114 54.1 }
" *c*	" 10	243 17.0	180 00.0	1 47.5	178 12.5	114 55.5 E.	114 55.5
Chillicothe	" 24	180 00.0	345 24.7	1 44.5	343 40.2	16 19.8 W.	16 22.1
Carrollton	" 27	180 00.0	295 55.7	1 43.7	294 12.0	65 48.0 W.	65 48.0
St. Joseph	Aug. 1	180 00.0	229 13.7	1 44.5	227 29.2	132 30.8 W.	132 30.8
Maryville	" 2	179 58.5	300 27.2	1 45.3	298 41.9	61 16.6 W.	61 16.6
Sedalia	" 8	180 00.5	353 23.7	1 42.7	351 41.0	8 19.5 W.	4 56.7
Jefferson City, *a* ..	" 9	180 00.0	35 06.5	1 42.7	33 23.8	33 23.8 E.	38 49.4
" *b* ..	" 10	214 26.0	245 59.0	1 42.7	244 16.3	150 09.7 W.	150 09.7
" *d* ..	" 11	179 58.9	177 09.7	1 42.7	175 27.0	175 28.1 E.	175 28.1
Washington	" 15	179 59.0	138 48.0	1 42.7	137 05.3	137 06.3 E.	137 06.3
Holden, *a*	" 17	179 59.7	18 03.5	1 42.7	16 20.8	16 21.1 E.	16 21.1
" "	" 18	179 55.7	17 58.0	1 42.7	16 15.3	16 19.6 E.	16 19.6*
Lexington, *a*	" 21	180 00.7	278 52.5	1 43.2	277 09.3	82 51.4 W.	82 51.4
" *b*	" 22	180 01.0	312 46.2	1 43.2	311 03.0	48 58.0 W.	48 58.0
Parsons	" 27	180 01.0	264 09.2	1 41.0	262 28.2	97 32.8 W.	95 51.1
Springfield	" 28	180 00.7	193 08.7	1 40.6	191 28.1	168 32.6 W.	168 32.6
Lebanon Hotel ..	" 29	148 43.0	179 58.5	1 41.5	178 17.0	150 26.0 W.	147 47.2
" yard....	" 30	0 01.5	38 27.7	1 41.5	36 46.2	143 15.3 W.	147 50.4
St. Louis, *e*	Sept. 8	180 00.7	90 43.7	1 41.8	89 01.9	89 01.2 E.	89 01.2
Collinsville	" 12	244 15.7	180 01.0	1 41.8	178 19.2	114 c3. E.	114 03.5

* See description of this station, p. 124.

MAGNETIC DECLINATION OR "VARIATION."

STATION.	Magnet Scale. Elongations. East.	Magnet Scale. Elongations. West	Magnet Scale. Mean.	Magnet Scale. Axis reads.	Magnet Scale. Reduct'n to Axis	Azimuth Circle. Circle reads.	Azimuth Circle. Magnetic South reads.	Azimuth Circle. Mark reads	Azimuth Circle. True south reads.	Declination East of North.	Date.	Remarks.
Iowa City, *a* ..	95ᵈ 2	90ᵈ 55	92ᵈ 87	76ᵈ 95	+37′.3	327° 15′.2	327° 52′.5	360° 00′.4	319° 49.2	8° 03′.3	July 1	Magnet C_6.
" *b* ..	83.35	78.3	80.82	77.32	+ 8.2	303 36.0	303 44.2	180 00.1	294 53.4	8 50.8	" 2	"
" " ..	79.4	74.75	77.07	77.32	— 0.6	303 52.5	303 51.9	180 00.6	294 53.9	8 58.0	" 3	"
" " ..	85.2	74.9	80.05	76.94	+ 7.3	303 42.5	303 49.8	180 00.8	294 54.1	8 55.7	" 5	"
" *c* ..	77.3	72.0	74.65	76.84	— 5.1	303 57.2	303 52.1	180 00.6	294 56.1	8 56.0	" 7	"
" " ..	78.37	73.5	75.93	76.99	— 2.5	269 03.5	269 01.1	145 12.5	260 08.0	8 53 0	" 11	"
Glasgow	86.5	79.3	82.90	82.95	— 0 2	98 55.0	98 54.8	180 00.7	90 33.9	8 20.9	" 21	(Magnet No. 1.)
"	86.8	78.5	82.65	83.10	— 0.9	98 56.0	98 55.1	180 00.2	90 33.4	8 21.7	" 22	....
Chillicothe ...	81.6	76.4	79.00	82.20	— 5.1	172 15.7	172 10.6	180 01.2	163 39.1	8 31.5	" 25	....
Carrollton	82.1	77.5	79.80	79.96	— 0.3	122 43.0	122 42.7	180 00.7	114 12.7	8 30.0	" 28	....
Kansas City ..	86.35	78.6	82.47	80.09	+ 4.5	142 43.7	142 48.2	179 16.3	132 40.6	10 07.6	" 29	....
St. Joseph	83.15	76.3	79.72	80.15	— 0.9	56 25.0	56 24.1	180 01.6	47 30.8	8 53.3	Aug 1	....
Maryville, *a* ..	82.9	74.5	78.70	79.95	— 2.4	129 56.7	129 54.3	179 55.0	118 38.4	11 15.9	" 2	....
" *b* ..	84.2	78.4	81.30	[79 95]	+ 2.6	152 12.5	152 15.1	179 59.2	141 03.2	11 11.9	" 3	....
" *c** .	85.2	78.3	81.75	[79.95]	+ 3.4	170 11.0	170 14.4	179 59.4	159 09.6	11 04.8	" 4	....
Sedalia	83.85	78.85	81.35	80.24	+ 2.1	183 44.7	183 46.8	179 59.7	175 03.0	8 43.8	" 7	....
"	82.1	78.95	80.52	[80.24]	+ 0.5	170 51.6	170 51.1	167 00.5	162 03.8	8 47.3	" 8	....
Jeffers'n City, *a*	83.0	76.6	79.80	80.02	— 0.4	227 35.0	227 34.6	179 58.2	218 47.6	8 47.0	" 10	....
" *b*	83.2	77.7	80.45	80.02	+ 0.8	218 23.0	218 23.8	360 00.1	209 50.4	8 33.4	" 11	....
" *c*	....	....	.....	.....	+ 5.7	216 50.7	216 56.4	178 32.7	208 08.8	8 47.6	" 13	8h. 30m. A.M.
" *d*	83.4	78.5	80.95	80.82	+ 0.2	363 55.0	363 55.2	179 59.9	355 28.0	8 27.2	" 12	....
Washington, *a*	82.5	78.1	80.30	80.05	+ 0.5	323 31.7	323 32.2	180 01.0	317 07.3	6 24.9	" 14	....
" "	82.85	78.6	80.72	[80.05]	+ 1.3	324 22.7	324 24.0	180 51.7	317 58.0	6 26.0	" 15	....
" *b*	.....	....	.....	.....	+ 3.0	322 48.5	322 51.0	180 00.0	316 28.9	6 22.1	" 16	9h. 23m. A.M.
" *c*	.....	....	.....	.....	+ 2.0	323 10.0	323 12.0	179 58.7	316 42.8	6 29.2	" "	10 45 "
" *d*	.....	....	.....	.....	0.0	323 35.5	323 35.5	179 59.6	317 08.2	6 26.8	" "	12 M.
" *e*	.....	....	.....	.....	— 3.0	323 27.0	323 24.0	179 58.6	317 04.9	6 19.1	" "	2 15 P.M.

* Not good. A rain interfered with this determination.

Magnetic Declination or "Variation" (continued).

STATION.	MAGNET SCALE.					AZIMUTH CIRCLE.				Declination East of North.	Date.
	Elongations. East.	Elongations. West.	Mean.	Axis reads	Reduction to Axis.	Circle reads.	Magnetic South reads.	Mark reads.	True South reads.		
Holden, *a*	82ᵈ6	75ᵈ7	79ᵈ15	[86ᵈ05]	− 1.7	205°15′.0	205°13′.3	179°59′.0	196°19′.6	8°53′.7	Aug. 17
" "	83.3	76.1	79.70	[80.05]	− 0.7	205 17.2	205 16.5	179 59.0	196 19.6	8 56.9	" 18
" *b*	85.2	78.5	81.85	[80.05]	+ 3.4	222 03.2	222 06.6	179 58.2	213 09.2	8 57.4	" 19
Lexington, *a*	85.0	79.0	82.00	80.10	+ 3.6	106 01.5	106 05.1	180 01.7	97 10.3	8 54.8	" 21
" *b*	83.9	77.5	80.70	[80.10]	+ 1.7	139 57.2	139 58.9	180 01.0	131 03.0	8 55.9	" 22
Schell City	81.5	77.0	79.20	80.30	− 2.3	157 46.5	157 44.2	180 00.5	148 41.5	9 02.7	" 25
Parsons, Ks.	82.3	78.0	80.15	[80.30]	− 0.3	93 41.7	93 41.4	180 01.5	84 10.4	9 31.0	" 26
" "	84.6	80.2	82.40	[80.30]	+ 4.0	93 41.7	93 45.7	180 02.0	84 10.9	9 34.8	" 27
Springfield	82.8	78.05	80.42	[80.30]	+ 0.2	20 05.5	20 05.7	180 02.5	11 29.9	8 35.8	" 29
Lebanon	83.0	76.0	79.50	80.40	− 1.7	40 03.5	40 01.8	179 59.5	32 09.9	7 51.9	" 30
"	84.5	77.1	80.80	80.40	+ 0.7	40 01.7	40 02.4	179 59.2	32 09.6	7 52.8	" 31
St. Louis, *e*	82.9	76.4	79.65	[80.40]	− 1.6	274 52.5	274 50.9	179 36.5	268 37.7	6 13.2*	Sept. 9
Collinsville, Ills...	83.0	78.9	80.95	80.40	+ 1.0	300 25.0	300 26.0	180 01.4	294 04.9	6 21.1	" 13

* See description of this station.

INTENSITY—OSCILLATIONS.

Station.	Date.	t'. Temp.	LOGARITHMS. T'^2.	$1+\frac{h}{f}$	$1-(t'-t)\ q$	T^2	k	mH.	H.	H.
Iowa City, *c*	July 6	89°	1.73400	0.00031	9.99923	1.73354	1.22352	0.48428	0.61553	4.1260
" "	" 7	83.8	1.73304	0.00033	0.00031	1.73368	1.22344	0.48406	0.61592	5.1297
Glasgow	" 21	89.0	1.68500	0.00036	9.99992	1.68528	1.22351	0.53253	0.66041	4.5752
Chillicothe	" 25	85.0	1.69166	0.00033	0.00076	1.69275	1.22346	0.52591	0.65577	4.5266
Carrollton	" 28	78.0	1.67464	0.00036	0.00104	1.67604	1.22334	0.54160	0.67027	4.6803
Kansas City	" 29	87.0	1.66790	0.00036	9.99983	1.66809	1.22349	0.54970	0.67967	4.7827
St. Joseph	" 31	95.3	1.68250	0.00036	9.99969	1.68255	1.22362	0.53537	0.66811	4.6571
Maryville, *a*	Aug. 2	81.6	1.68890	0.00028	9.99975	1.68893	1.22341	0.52898	0.65681	4.5374
" "	" 3	77.5	1.68726	0.00027	0.00060	1.68813	1.22334	0.52951	0.65728	4.5424
" *b*	" 4	86.6	1.68980	0.00044	9.99871	1.68895	1.22348	0.52883	0.65660	4.5352
Sedalia, *b*	" 8	74.8	1.66318	0.00039	0.00168	1.66525	1.22329	0.55234	0.68245	4.8134
Jefferson City, *a* ..	" 10	81.3	1.67410	0.00044	9.99915	1.67369	1.22341	0.67332	0.67332	4.7132
" *b* ..	" 11	93.3	1.67040	0.00041	9.99808	1.66889	1.22359	0.54900	0.67885	4.7736
" " ..	" 11	88.7	1.66896	0.00034	9.99904	1.66834	1.22351	0.54947	0.67908	4.7762
" *d* ..	" 12	81.3	1.66838	0.00034	9.99915	1.66787	1.22340	0.54983	0.67826	4.7670
" *c* ..	" 13	91.2	1.67868	0.00043	9.99706	1.67617	1.22355	0.54168	0.67098	4.6879
Washington, *a* ...	" 15	77.1	1.66964	0.00037	9.99937	1.66938	1.22333	0.54825	0.67644	4.7373
Holden, *a*	" 17	89.6	1.66272	0.00032	9.99924	1.66228	1.22353	0.55555	0.68555	4.8479
Lexington, *a*	" 21	84.1	1.67300	0.00035	0.00049	1.67384	1.22344	0.54390	0.67353	4.7155
" *b*	" 22	87.8	1.67430	0.00039	9.99973	1.67442	1.22350	0.54338	0.67301	4.7094
Schell City	" 25	83.3	1.65664	0.00046	0.00131	1.65841	1.22344	0.55933	0.69005	4.8984
Parsons, Ks.	" 26	89.0	1.64226	0.00043	0.00075	1.64344	1.22352	0.57438	0.70584	5.0797
Springfield	" 29	85.6	1.63908	0.00048	0.00047	1.64003	1.22347	0.57774	0.70886	5.1152
Lebanon	" 30	91.7	1.65222	0.00078	0.00070	1.65340	1.22356	0.56446	0.69731	4.9809
St. Louis, *e*	Sept. 3	67.8	1.67542	0.00054	9.99925	1.67521	1.22319	0.54228	0.66987	4.6759
" "	" 9	67.3	1.67578	0.00056	9.99935	1.67569	1.22319	0.54180	0.66939	4.6708
" "	" 9	66.6	1.67544	0.00052	9.99950	1.67546	1.22317	0.54201	0.66960	4.6730
Collinsville, Ills. .	" 13	74.8	1.68140	0.00053	0.00141	1.68334	1.22329	0.53425	0.66588	4.6332

INTENSITY—DEFLECTIONS.

STATION.	Date.		t.	r ft.	LOGARITHMS.			
					u^d.	$1 + \frac{h}{f}$	Corrected tan u.	$\frac{m}{H}$
Iowa City, *c* ..	July	7	86.0	2.00	1.72746	0.00071	8.65309	9.25502
" " ..	"	"	84.7	1.75	1.89892	0.00065	8.82490	9.25144
Glasgow	"	21	88.0	2.00	1.68381	0.00086	8.60945	0.21038
"	"	"	89.3	1.75	1.86011	0.00092	8.78628	9 21287
Chillicothe	"	25	88.1	2.00	1.68699	0.00085	8.61268	9.21361
"	"	"	89.3	1.75	1.86070	0.00088	8.78675	9.21334
Carrollton	"	28	82.5	2.00	1.67486	0.00084	8.60051	9.20144
"	"	"	83.3	1.75	1.84813	0.00084	8.77409	9.20068
Kansas City ...	"	29	85.8	2.00	1.66356	0.00075	8.58914	9.19007
" ...	"	"	86.6	1.75	1.83806	0.00089	8.76406	9.19065
St. Joseph	"	31	94.7	2.00	1.67265	0.00089	8.59835	9.19923
"	"	"	94.9	1.75	1.84646	0.00086	8 77246	9.19905
Maryville, *a* ...	Aug.	3	81.5	2.00	1.68815	0.00077	8.61422	9.21515
" " ...	"	"	79.3	1.75	1.86216	0.00085	8.78818	9.21477
Sedalia, *b*	"	8	82.6	2.00	1.65984	0.00089	8.58551	9.18644
" "	"	"	82.2	1.75	1.83594	0.00083	8.76187	9.18846
Jefferson City, *b*	"	11	82.7	2.00	1.66401	0.00086	8.58967	9.19060
" "	"	"	85.4	1.75	1.83798	0.00093	8.76401	9.19060
" *d*	"	12	76.0	2.00	1.66668	0.00091	8.59241	9.19334
" "	"	"	78.4	1.75	1.84065	0.00091	8.76667	9.19326
Washington ...	"	15	74.1	2.00	1.66908	0.00065	8.59454	9.19547
" ...	"	"	74.1	1.75	1.84283	0.00075	8.76869	9.19528
Holden	"	17	86.8	2.00	1.65807	0.00083	8.58371	9.18464
"	"	"	87.2	1.75	1.83179	0.00081	8.75769	9.18428
Lexington, *a* ..	"	21	86.0	2.00	1.67053	0.00077	8.59612	9 19705
" " ..	"	"	87.0	1.75	1.84409	0.00081	8.77003	9.19662
Schell City	"	25	89.7	2.00	1.65297	0.00117	8.57899	9.17992
"	"	"	89.5	1.75	1.82570	0.00117	8.75197	9.17856
Parsons, Ks. ..	"	26	91.5	2.00	1.63642	0.00104	8.56224	9.16317
" " ..	"	"	93.7	1.75	1.80951	0.00109	8.73564	9.16223
Springfield	"	29	86.6	2.00	1.63365	0.00108	8.55878	9.15971
"	"	"	89.2	1.75	1.80758	0.00109	8.73373	9.16032
Lebanon	"	30	94.7	2.00	1.64326	0.00117	8.56921	9.17014
"	"	"	95.5	1.75	1.81674	0.00116	8.74296	9.16955
St. Louis......	Sept.	8	64.6	2.00	1.67417	0.00129	8.60033	9.20126
"	"	"	63.9	1.75	1.85076	0.00132	8.77722	9.20381
Collinsville, Ill.	"	13	82.5	2.00	1.68266	0.00128	8.60880	9.19973
" "	"	"	80.7	1.75	1.85251	0.00124	8.77889	9.20525

Inclination, or Dip.

Needle No. 2.

Station.	Marked End. North.	Marked End. South.	Means by Polarities Series I.	Means by Polarities Series II.	Result'g Dip.	Date.
Iowa City, *c* ..	71°57'·1	72°07'·8	72°05'·1	71°59'·8	72°02'·4	July 11
Glasgow	69 47·7	70 04·8	70 03·0	69 49·5	69 56·3	" 22
Chillicothe	70 17·0	70 13·5	70 19·1	70 11·5	70 15·3	" 25
Carrollton	69 21·3	69 31·5	69 22·5	69 30·3	69 26·4	" 28
Kansas City...	68 54·5	69 00·9	69 10·3	68 45·2	68 57·7	" 29
St. Joseph	69 31·5	69 40·0	69 43·0	69 28·5	69 35·7	" 31
Maryville, *b* ...	69 59·3	70 06·7	70 11·5	69 54 5	70 03·0	Aug. 4
Sedalia, *b*	68 37·8	68 51·3	68 51·9	68 37·2	68 44·5	" 8
Jefferson City, *d*	68 51·8	68 53·1	68 55·2	68 49·7	68 52·5	" 12
Washington ...	68 59·0	69 14·5	69 08·1	69 05·4	69 06·7	" 15
Holden, *a*	68 17·3	68 26·0	68 30·7	68 12·5	68 21.6	" 19
Lexington, *b* ..	69 00·7	69 10·4	69 16·1	68 55·1	69 05·6	" 22
Schell City	68 05·4	68 20·7	68 21·1	68 05·1	68 13·1	" 25
Parsons, Ks. ..	66 57·7	67 21·9	67 14·3	67 05·3	67 09·8	" 26
Springfield	67 28·2	66 51·1	67 27·9	66 51·4	67 09 6	" 29
Lebanon	67 46·3	67 56·1	67 55·7	67 46·7	67 51·2	" 31
Collinsville ...	69 31·2	69 35·0	69 41·6	69 24·6	69 33·1	Sep. 13

Needle No. 3.

Station.	Marked End North.	Marked End South.	Means by Polarities Series I.	Means by Polarities Series II.	Result'g Dip.	Date.
Iowa City, *c* ...	72°30'·7	71°35'·5	72°01'·1	72°05'·1	72°03'.1	July 11
Glasgow	70 31·0	69 26·1	69 56·1	69 57·5	69 58·5	" 22
Carrollton	70 04·5	68 59·0	69 30·2	69 33·2	69 31·7	" 28
Kansas City ...	69 23·5	68 35·5	68 52·9	69 06·2	68 59·5	" 29
St. Joseph	70 23·2	69 18·7	69 52·8	69 49·1	69 50·9	" 31
Maryville, *b* ...	70 43·5	69 33·6	70 08·1	70 09·0	70 08·5	Aug. 4
Sedalia, *b*	69 32·7	68 17·1	68 59·3	68 50·4	68 54·9	" 8
Jeffers'n City, *d*	69 37·3	68 20·6	68 59·8	68 58·0	68 58·9	" 12
Washington ...	69 42·9	68 34·3	69 08·0	69 09·1	69 08·6	" 15
Holden, *a*	69 12·8	68 01·3	68 42·4	68 31·6	68 37·0	" 19
Lexington, *b* ..	69 54·9	68 48·8	69 25·4	69 18·3	69 21·8	" 22
Schell City....	69 00·8	67 53·7	68 33·7	68 20·8	68 27·2	" 25
Parsons, Ks. ..	67 46·6	66 43·2	67 16·9	67 12·9	67 14·9	" 26
Springfield	67 06·3	67 24·7	67 16·4	67 14·6	67 15·5	" 29
Lebanon	68 36·9	67 30·9	68 07·1	68 00·8	68 03·9	" 31
Collinsville ...	70 12·4	69 14·1	69 48·8	69 37·7	69 43·2	Sep. 13

Remarks on the Results.

The chart which accompanies this report represents the declination determinations thus far made in Missouri, and we have added a map of the adjoining State of Iowa in order to represent the results of a preliminary survey of Iowa by Dr. G. Hinrichs. The isogonic lines here shown in Iowa are given as published by him,* except that the 9° and 8° lines in central Iowa are thrown half a degree to the east, my results four miles west of Iowa City differing from Hinrich's determinations in the University campus by this amount. The determinations made in the city have been very discordant, and not much reliance is to be placed upon them.†

On inspection of the chart of isogonic lines it will be observed that these lines exhibit remarkable flexures, which evidently bear a very intimate relation to the drainage systems of the regions.

Prof. Hinrichs had detected these flexures in 1878, but his stations were so few in number and so widely separated that he did not feel perfectly certain of the facts. My own work, begun a little earlier during the same year, did not cover enough ground to bring out these featnres during 1878. During the summer of 1879, however, we pushed the work south of the Missouri river and west of Lon. 92° 30′, and the evidence on this point was placed beyond all question. It is perhaps worthy of remark, that each had made arrangements for the survey of his own State without the knowledge of the other.

The explanation which Prof. Hinrichs gives of these irregularities is contained in his "Theory of the Magnetism of the Earth," published in Copenhagen in 1860.

His hypothesis is that the earth's magnetism is due to the motion (rotation and translation) of the earth in ether, thus giving rise to ether streams in the earth; and he then predicted that ocean currents, by virtue of the motion of the water, would, when properly directed, accelerate or retard the ether stream, thus in-

* See Weather Report for April, 1878.
The Iowa stations are indicated on the map thus "o."

† Compare my own determination at station *a* in the present report.

creasing or diminishing the magnetic intensity. The same explanation he now applies to rivers.

My own explanation is as follows. Assuming the existence of earth currents of electricity, the general direction of which is from east to west, they distribute according to well-known laws, flowing in greatest quantity through the lines of least resistance. The magnetic needle tends to set at right angles to the current, following the well-known law enunciated by Ampère. Where the general direction of the moist river valley is at right angles to the normal position of the magnetic needle, the position of the latter is not changed, as the tendency of the needle is to set at right angles to a current of electricity. In such a valley (as, for instance, in the Missouri valley between Jefferson City and the mouth of the river), the direction of the needle should be normal, the direction in which the water flows being without (appreciable) effect.

Where the river runs at right angles to the earth currents, the disturbing cause would be practically removed, as there would be no deflected component of the earth current along the river valley.

The maximum effect is produced in the case of rivers making an angle of 45 degs. with the general direction of the earth currents. Of course, this effect would be most marked where the river and valley is very large, as in the case of the Mississippi and Missouri, or where we have an immense drainage system consisting of long rivers and creeks running parallel and in the proper direction, as is the case on the eastern slope of Iowa.

At present, the above explanation is suggested as a probable one. During next summer it is the intention to make simultaneous determinations of the intensity of earth currents in the Missouri valley and on the high prairie to the south. This will be done by aid of private telegraph lines which will be built for the purpose. It is the intention to put in a north and south, and an east and west line at each station, making also simultaneous declination determinations. By this meaus it is hoped that the question may be solved.

Whether the explanation above suggested be the true one or not, the deflection of the 11° and 10° lines to the east in the western part of Iowa, the abrupt bends between St. Joseph and Kansas City and between Glasgow and Jefferson City, the westward bending of the 8° and 8° 30′ lines in the Osage Valley as compared with the 9° line in the same latitude and the remarkable flexures in eastern Iowa, are all in harmony with it.

A comparison of these lines with the tables of declination given in the two reports will show the accuracy with which the facts are represented.

The determinations made at Jefferson City (see descriptions of stations, pp. 121–125) are likewise of interest in this connection.

In the following table *d* represents the distance (in yards) of the observations from the middle of the river; *H*, the horizontal intensity, and δ the observed declination; *h*, the elevation above high water.

Station.	*d*.	*H*.	δ.	*h*.
c	0	4.688	8° 47′.6	0
a	200	4.713	8. 47 .0	75 ft.
b	275	4.776	8. 33 .4	85 "
d	1000	4.767	8. 27 .2	about 125 "

Making all due allowance for possible influence due to disturbing causes at stations *a* and *b*, there remains strong proof of a regular and marked change in these values as we recede from the river, and a more minute local survey is therefore contemplated in order to determine the facts beyond question.

Contribution to the anatomy of the genus Pentremites, with description of new species.

By G. Hambach.

One of the many interesting classes of fossils belonging to our subcarniferous fauna is that of the *Blastoida*, and in it the genus *Pentremites* is of especial interest, not only on account of the abundance of the specimens which appear in some of the strata, but equally, if not more so, on account of their excellent state of preservation and the entire absence of living representatives.

They have occupied the attention of many able writers, and form, according to current opinion, a connecting link between the true *Crinoids* and the *Echinoids*, with perhaps a little more resemblance to the latter. The conclusions arrived at by the study and examination of more or less suitable material in regard to the anatomy of the calcareous shell forming the calyx, as well as of the functions assigned to the different organs preserved in it, are by no means unanimous; and as the specimens are in most cases represented by insufficient or incorrect figures, the external aspect of some has been made to differ so much from that of others as to cause the creation of new genera or of separate groups, although the pieces forming the calyx remain the same in number throughout the whole genus, and one who allows considerable latitude, yet may not justify this separation, and may regard the differences as specific rather than generic.

It, therefore, becomes almost a necessity to recapitulate the history of this genus in order to determine the true condition of the fossil in question. Having had an opportunity to study a large and excellent material, partly in my own possession, and numbering several thousand specimens in almost every stage of preservation, I may be able to contribute something to our present knowledge of this curious being. In describing the same I shall adopt the old terminology given by Roemer, for various reasons: (1) the old names denote more clearly the forms and conditions of the object to which they are applied—as "radial pieces," etc.; (2) as already mentioned, the specific characters and number of pieces remain the same throughout the whole genus; (3) they form an entirely isolated class of animals belonging neither to *Crinoids* nor to *Echinoids.*

The *Pentremites* are mainly composed of two parts, i.e. the calcareous shell and the softer internal organs. The former, generally the best preserved part, is variable, globose, ovoid, pyriform, or clavate, composed of a number of pieces attached to a little slender column by which the animal was fixed to a certain place.

The body represents a closed calcareous shell, with a few openings on the summit, the poral openings of the ambulacral field, and a small opening at the base. We observe on its external surface five plainly marked areas, called pseudo-ambulacral fields, passing from the summit, in shape of a star, more or less over the sides of the body. The following table gives the number of pieces characterizing this genus:

3 Basal plates.
5 Forked plates = radial pieces.
5 Deltoid plates = interradial pieces.
5 Lancet plates.
Poral pieces, irregular in number, forming with the latter the ambulacral field, which is covered by a zigzag plicated integument and pinnulas.
Mouth central.
Anal aperture lateral.
Ovarian apertures 2×5 arranged around the mouth.

The Base or Pelvis (Muenster), Plate A, Fig. 1. — This is composed of three pieces; two equal in size and pentagonal, the other smaller and quadrangular. Its shape varies in different species; in some it is in the form of a flat plate, in others in that of a reversed cone or column. It is perforated in the centre by a very small opening corresponding to that of the column. Its pieces are of equal thickness, with a smooth internal surface. The external surface is plain, or marked by granules, or by fine striæ, with a concentrically lineated round or triangular articulating surface for the column in the centre. This articulating surface is, in many species (as *sulcatus*, *robustus*, *pyriformis*, and others), surrounded by a triangular or clover-leaf shaped furrow, which induced some authors* to suppose that the base

* Lyon and Billings.

was composed of twice three pieces; but numerous examinations of isolated pelves have convinced me of the fact that this furrow is only superficial and not a separating suture. It is correctly described by Quenstedt.*

The Forked pieces.—The forked or radial pieces are five in number. In shape they resemble a rectangle in which the upper corners are wanting. The forked appearance is due to a sinus, of varying depth, which runs obliquely from the superior margin inwardly, so that the surface between its external margins is larger than that between the internal ones. It slopes towards one side and thus gives each prong a more or less three-cornered appearance. The internal oblique surfaces of the prongs are covered with a number of minute transverse ledges (Plate *a*, Fig. 2) which connect them with the poral pieces. At the base of the sinus are two little crests to support the apex of the lancet pieces. The base of the fork pieces, as indicated by the sinus, varies very much in form and size from a little lamella barely large enough to furnish a support for the prongs, to a most solid and substantial part of the piece: see Plate *a*, Fig. 2*a*, as in *P. sulcatus* and others. In such cases the transverse diameter of the fork pieces at the apex of the ambulacral field presents a triangular or semi-lunar form with the greatest surface at the point from which the external surface slopes downward and inward: see Plate *a*, Fig. 3. The lower margin forming the connection is then equally as thick as that of the basal pieces. The interior surface of the base portion of such a fork piece, which in some cases is as large or larger than the prongs themselves, is straight or concave, and the form of cast accordingly receives such modifications that it may seem to belong to an entirely different individual; for example, *Pentremites laterniformis* (Shum.) is a cast of *P. sulcatus.*†

* Quenstedt, Handbuch der Petrefaktenkunde, p. 755.

† It seems that it is not generally understood to what species the cast described by Dr. Shumard as *Pentremites laterniformis* belongs; for S. A. Miller, as well as the Doctor, but not Rœmer, takes it to be identical with *P. obliquatus* (see Miller's Palæozoic Fossils, p. 86, and Trans. of the St. Louis Acad. of Science, vol. ii. p. 384). I will state here that I have seen the original specimen serving the Doctor for his description and that I afterwards collected specimens in the same locality from which the Doctor's specimen was obtained, showing *P. sulcatus* (Rœmer) on one side and the *laterniformis* on the other side see Pl. B, Fig. 10), convincing me without doubt to which fossil this cast belongs. The lower pentagonal portion of the body is due to the straight inner surface of the lower part of the fork pieces.

The external edges are flattened to form a surface for connection with the adjoining pieces, and the upper points of the prongs slope inwardly for connection with the lower lateral processi of the deltoid pieces. Their external surface is plain, or, when ornamented, the ornamentation is similar to that of the pelvis. Two of the fork pieces rest, each on one of the pentagonal plates; while the three others rest, each on two adjoining ones.

The Deltoid pieces. — The deltoid pieces, which may be regarded as keystones in the arch forming the roof of the calyx, may be divided into two parts, on account of their structure (see Plate *a*, Fig. 4 & 5 *a b*), i.e. one external lateral, from which the name is derived, and one internal horizontal which enters into the composition of the central orifice and in part of its surrounding openings.

The external lateral part, when present, has, as the name denotes, a more or less deltoid or arrow-head shape, with two unequal angles. It varies very much in size, from a hardly perceptible piece to the most essential part of the calyx, as in *Pentremites Sayi.* In some species its external surface is ornamented. The most obtuse of the angles is directed downward, and has (in the typical species) on its lower oblique margins two processi running obliquely and inwardly, which are hidden externally by the superior points of the fork pieces.

The internal horizontal part, i.e. the main and base portion of the body, because it is never missing, is lamellar running from the interior outwards, where its apex suddenly developes into the deltoid expanded surface; or, when this is absent, the apex receives a three-cornered incision for the reception of the acute points of the fork pieces. The interior portion is expanded on each side and concave, thus forming the central orifice (s. *annulus centralis*, Plate *a*, Fig. 8), as well as, in connection with the lancet pieces, the surrounding openings. Its position is a little oblique and therefore the external diameter is less than the internal. It is thicker than it is wide, and has a lower concave edge, thus giving to the calyx its dome shape. On each side it has an oblique plicated lamella sloping from the centre to the deltoid expansion for the support of the hydrospiric plicas and ovarian tubes. The upper edge is convex, so that, in some species, the acute point of the deltoid edge becomes a projecting rostrum above the summit of the calyx, whereas in others, as for instance *Pentremites Norwoodi*, the expansion is lateral and horizontal, in which case it is perforated in the centre to afford a passage for the ovalum.

The Ambulacral field (see Plate *a*, Fig. 6 & 7). — The ambulacral field, i.e. the calcareous portion of it, is composed of three parts and the pinnulæ: first, the lancet piece; second, the poral pieces: third, the zigzag plicated integument covering the former.

A. The lancet piece, which varies very much according to the dimensions of the ambulacral field, from a regular lancet-shaped piece to a mere linear lamella, closes the ambulacral opening, with the exception of a three-cornered furrow on each side.

Its anterior side is smooth and slightly convex, whereas the posterior is concave, semilunar, and grooved in its whole length for the reception of some duct or vessel. On this side we find, on its upper portion, a little process, which is concave laterally and three-cornered at the apex, by which it connects with the *annulus centralis*; its lateral concave furrow forms, in connection with the corresponding portion of the deltoid piece, the ovarian aperture. In the majority of the species, or at least in the typical ones, as *Pentremites florealis*, *sulcatus*, *pyriformis*, etc., the width of the lancet piece is half as great as that of the ambulacral field, being also pierced through the centre, in its whole length, by a very fine canal, which led Mr. Rofe* to suppose that it was composed of two pieces. Numerous examinations of cross-sections have convinced me, however, that this is not the case, as I have, in entirely well-preserved specimens, found this minute canal right in the centre (see Plate *a*, Fig. 9); also, in some specimens, either near the anterior or posterior surface. In specimens in which the opening is in the centre, it may be seen laid open externally if the covering layer is removed by process of weathering or acid, though in the majority of cases it will probably be found entirely obliterated and therefore invisible.

B. Poral pieces. These pieces which, in typical cases, are very

* Geol. Mag., vol. ii. p. 249.

small three-cornered segments of about $\frac{1}{80}$ of an inch in thickness, have unequal margins, of which the largest, joining with the fork piece, is convex, while the opposite one, joining with the lancet piece, is concave. They close up the furrow on each side of the lancet piece, and according to its dimensions they will vary in size like the rest of the pieces forming the calyx. They are inserted edgeways, and have, on each side of the margin which connects with the fork piece, a minute semilunar sulcus, which with its opposite fellow forms a poral opening (see Pl. *a*, Fig. 7).

c. The zigzag plicated integument. This may be regarded as a band, which is transversely plicated and covers the whole ambulacral field: it was probably of an elastic texture during the lifetime of the animal. It commences at the apex of the ambulacral field running in a zigzag from the lateral marg n to the median line, so that the poral openings are always placed between two returning folds, which are flattened here to form a sort of articulating surface for the pinnulæ. It ascends in this manner, covering half of the ambulacral field to the summit of the calyx, where it surrounds in a very acute angle two of the ovarian openings and descends in a like manner on the following ambulacral field (see Plate *a*, Fig. 10). These acute points, which almost come in contact with each other at the summit, are the only covering of the central opening, which was never closed by additional plates, as intimated by some authors* ; although specimens are frequently found (and I have such in my collection) where it appears as if the summit were closed by additional plates, which, on close examination, however, prove to be *Bryozoa* or ovulum-like bodies. Again, it seems improbable to suppose that the central opening was closed if we compare our fossils with *Echinoderms*, with which they have unquestionably most affinity both as regards the calcareous shell as well as the interior of the visceral cavity (except as regards the number and arrangement of pieces). This can easily be comprehended if we divide the calyx into two equal halves, i.e. an upper or dorsal and an under or ventral one, of which the ventral one would be composed of the pelvis and fork pieces, and the dorsal one of the deltoid pieces

* Billings and Shumard.

and ambulacral fields (see Plate *a*, Fig. 11 & 12). Supposing the column to be absent, we would have an analogue of an Echinus, except that mouth and vent are placed, together with the ovarian openings, on the dorsal part of the shell instead of being on the ventral side as in true Echinoids.

*The Pinnulæ.** —The pinnulæ are little thread-like appendages, nearly as long or a little longer than the ambulacral field. They are composed of small alternate pieces about as long as wide, and situated along the lateral margin of the ambulacral field, articulating with the flattened surface of the retreating angle of the zigzag plicated integument, so that the poral openings remain free between each two pinnulæ. They are not placed on the poral openings as supposed by Dr. Rœmer. These poral openings, as it appears, must have remained free; because we frequently find the remnants of collapsed tentacles preserved in them, the so-called supplementary poral pieces.

The interior organs.—In the foregoing I have tried to describe the different parts composing the calcareous shell of the animal, and will now, in like manner, proceed to the description of the softer parts or organs which were protected by the calcareous shell, though both are so intimately connected with each other that one could not exist without the other. If we examine these parts, which, in some cases, are very beautifully preserved, we shall see that they are placed below or above each other; and if we commence with that portion which is placed immediately under the lancet piece of the ambulacral field (see Plate *a*, Fig. 9 *a*), we will find here a longitudinal duct or vessel resting in the concave furrow of the lancet piece, and running from the apex of the ambulacral field to the summit, where it connects with a circular duct (œsophageal ring?) surrounding, on the interior side, the central orifice or *annulus centralis*. This I have been so fortunate as to obtain entire from a well-preserved specimen of *Pentremites Norwoodi*; though, being probably composed of a very fine and delicate tissue or membrane, it is destroyed in most cases, and therefore very rarely observed. Next

* The terms "pinnulæ" and "tentacle" are here used in the sense of John Mueller; that is, "pinnulæ" for the more solid organs composed of calcareous matter, and "tentacle" for the softer and membranaceous ones, such as occupy the pores of the ambulacral field in Echinoderms.

and directly under this duct we find an organ (Plate *a*, Fig. 9 *b*) which is probably designed for the function of respiration according to Billings, and termed "hydrospire" by him. It represents a membranaceous sack of peculiar construction, as it can not very well be of calcareous lamellæ, admitting Billings' definition to be a correct one. It occupies, longitudinally, half the under surface of the ambulacral field, covering closely one side of the duct above it, and connecting its lateral acute margin with the poral fissure, whereas the other side of it — that is, the one which faces the visceral cavity or the vertical axis of the calyx — is folded in 2, 3, 4, 5 or more plications according to the different species, though these plicas often vary in number in the same specimen. These foldings are so arranged that they represent an unsymmetrical figure 8, of which the upper loop is larger than the lower one. This sack commences also at the apex of the ambulacral field and runs to the summit, where each of the plicas are resting in little grooves placed at the lateral expansions of the deltoid pieces, and do not unite with the adjoining sack into one tube, as supposed by some authors. As already stated, the acute lateral margin is situated under the poral fissure from whence the tentacles originate, leaving the interior of the calyx through the poral openings, and forming in their collapsed state the supplementary poral plates of Dr. Roemer. This can easily be observed in good and suitable specimens by grinding off the lateral margin of an ambulacral field, where we will find that the interior circumference of a poral opening is lined with a membranaceous integument. In such well-preserved specimens we may also observe that the upper loop of the plications surrounds, or that the cavity produced by these folds is filled out by, a tube, which I suppose to be the ovarian tube, and which has its outlet through the ten openings surrounding the *annulus centralis;* explaining, on the other hand, the necessity of the grooves for the support of the hydrospiric plication, which by this arrangement are kept from obstructing the free passage of the ovulum. It will be seen from the whole arrangement that the central opening as well as the surrounding ones could not well have been closed, as it also contradicts the supposition that two of the hydrospires were united into one tube; because, if so, then this union could only have been formed external to the cavity: for instance, in

Pentremites melo, where the base portion of the deltoid piece is so broad, and the shell so very thin, that it never appears as if the central opening was surrounded by only five instead of ten distinct openings, excluding the lateral one for the anus. We will have, therefore, twelve openings on the summit in all true Pentremites, i.e. one central for the mouth, one lateral for the anus, and ten acting in a double capacity; that is, as spiracle and also as ovarian outlet. The alimentary canal, which from analogy I suppose has occupied the rest of the interior cavity, has not been observed so far, though I have often found large tubular fragments in cross-sections, but too insufficient to justify any definite opinion.

If we now, in short, compare the different subgenera of *Pentremites*— that is, *Granatocrinus* and *Troostocrinus*—in order to determine the justification of having them separated from *Pentremites*, we will find that *Granatocrinus* has a globose or ovoid form of the calyx, with very small or linear ambulacral fields extending almost over the entire surface of the body, with, generally, a small pelvis more or less depressed. *Troostocrinus* has a pear-shaped body; base portion generally more or less expanded, with a triangular or cloverleaf-shaped depression or indentation; ambulacral fields narrow and lineary, similar to those of Granatocrinus: and a triangular articulating surface for the column. But all these peculiarities are met with in different degrees in true Pentremites, and are so common that it is often very difficult to say where the dividing line of two species should be; for we have true *Pentremites* with a globose body and a depressed pelvis and somewhat narrow ambulacral fields, as well as clavate-shaped forms, with lineary or broad ambulacral fields with three edges flattened on the base portion; the indications of the triangular depression; also with the triangular articulating surface for the column. The deltoid pieces are subject to all these variations as well as all the other parts forming the calyx. For instance, in *Pentremites Sayi*, as already stated, where the apex of the deltoid piece is so expanded as to form the most essential part of the calyx; in *P. melo* it is very small, and shows beautifully the arrangement of the ovarian openings; in *P. Norwoodi* its rostrum is horizontally so expanded that Nature found it necessary to perforate the same in order to give an outlet to the ovulum. All these are characteristics which are more developed in one than in another, forming so a series of connections which, however, can only be specific and not generic.

Again, we hardly can find another fossil so subject to abnormal developments as the one in question; for I have a number of such specimens in my collection, as, for instance, one with six ambulacral fields; one with five ambulacral fields but only four fork pieces; another with five fork pieces but only four ambulacral fields; another in which a longitudinal piece is inserted between two fork pieces (see Plate B, Fig. 11): one with a half-developed ambulacral field; another with a spinal excrescence on one of the pelvis plates, and others;—though all these bear the character of abnormity and never will be mistaken for separate species.

PENTREMITES SPINOSUS, n. s. (Plate B, Fig. 1.)

Body medium size, subglobose. Pelvis small, representing a moderately convex disc of a little less than $\frac{1}{3}$ the transverse diameter of the body. Fork pieces broad and nearly as long as $\frac{3}{4}$ of the entire length of the body: base portion of the same, sloping abruptly towards the margin of the pelvis; upper portion of the same, towards the separating suture of the adjoining piece, having on each side, at the apex of the ambulacral fields, a very projecting spine $\frac{1}{10}$ of an inch in length. Deltoid pieces small, lanceolate; its upper acute angle, which projects above the summit, is slightly bent outwards, whereas its lower obtuse angle is bent inwards, forming here a little pit at the junction of the deltoid and fork pieces. Ambulacral fields broad, concave, and very depressed. Lancet pieces a little more than half the width of the field. Poral pieces thin, numbering 9 to $\frac{1}{10}$ of an inch. All apertures on the summit rather small and closely arranged. Surface ornamented with fine striæ.

Dimensions—Vertical height $\frac{7}{10}$ of an inch, width nearly $\frac{8}{10}$ of an inch, width of ambulacral field $\frac{5}{20}$ of an inch.

This species resembles in its general aspect the *Pentremites sulcatus*, but is readily distinguished from the same by the spines on each side of the ambulacral field.

Geological formation and locality—In the Kaskaskia limestone: at Chester, Illinois, very rare.

PENTREMITES NODOSUS, n. s. (Plate B, Fig. 2.)

Body subovoid, angularly; the base portion of the calyx below the apex of the ambulacral areas not quite so long as the part above. Pelvis cup-shaped, and rather large for the size of the specimen in comparison with other species. Fork pieces as long as $\frac{2}{3}$ of the entire length of the body; base portion of the same sloping gently towards the upper margin of the pelvis, whereas the upper points of the prongs have a prominent tubercle at the junction with the deltoid pieces. Deltoid pieces small, arrow-head shaped, twice as long as wide, and not projecting above the summit. Ambulacral areas slightly depressed and rather concave. Lancet pieces occupying half the space of the field. Poral pieces small, numbering from 8 to 9 in $\frac{1}{10}$ of an inch. All apertures on the summit rather large, but closely arranged. Surface ornamented with fine striæ running parallel to the sutures of the plates. Transverse diameter not quite so large as the vertical one.

The tubercles at the junction of deltoid and fork pieces distinguish this species from *Pentremites cervinus*, which it resembles very much otherwise.

Geological formation and locality—In the Kaskaskia limestone: Randolph county, Illinois, rare.

PENTREMITES ABBREVIATUS, n. s. (Plate B, Fig. 3.)

Body depressed, conoidal, wider than long; base portion horizontal. Pelvis small and slightly depressed. Fork pieces comparatively large, with a horizontal base in the same level of the pelvis. Deltoid pieces rather large and not projecting above the summit. Ambulacral areas wide and convex, extending from the base to the summit; lancet pieces half as wide as the ambulacral field; poral pieces moderately large, counting 8 to $\frac{1}{10}$ of an inch. All apertures on the summit small and closely arranged. Surface smooth and not ornamented.

Dimensions—Height of specimen $\frac{1}{2}$ inch; greatest width at the apex of ambulacral field $\frac{3}{4}$ inch.

Geological formation and locality — In the upper layer of the Kaskaskia limestone: Evansville, Illinois, very rare.

This species resembles very much a small Echinus in general aspect, and is easily distinguished from others by its large transverse diameter in comparison to the less vertical one.

PENTREMITES POTTERI, n. s. (Plate B, Fig. 4.)

Body globose, nearly as wide as it is long. Pelvis very small, not extending much beyond the articulating surface of the column. Fork pieces very short, only $\frac{1}{4}$ of the entire length of the body; ornamented with striæ running parallel to the suture, and a little hook-like projection at the apex of the ambulacral field. Deltoid pieces very large, covering $\frac{3}{4}$ of the body, being laterally framed by striated ridges which unite at the summit, leaving a depressed triangular space between them; this depressed surface is divided by a central lineary crest into two equal parts and ornamented with little granules. Ambulacral fields very small and lineary, running nearly over the entire surface of the body. Lancet pieces $\frac{1}{2}$ as wide as the ambulacral field. Poral pieces comparatively large for the size of the specimen, numbering 8 to $\frac{1}{16}$ of an inch, and sunk below the level of the lancet piece. Mouth central, round; ovo spiracle apertures and anus very small, and kept separate by the broad deltoid pieces; they are surrounded by the zigzag plicated integument in this as well as in other species, but too diminutive and not near enough to the central orifice for two of these openings to become united into one as in other species.

Dimensions — $\frac{7}{16}$ of an inch in width, and also the same in length.

Geological formation and locality — In the Burlington limestone: at Burlington, Iowa.

This fossil differs from *Pentremites Sayi*, which it most resembles, in that it is generally smaller, in that the pelvis is not concave, the fork pieces not arched at the junction of the deltoid piece, and this latter is not elevated and ornamented with transverse striæ, but depressed and granulated.

I named this beautiful fossil in honor of Prof. W. B Potter of Washington University.

PENTREMITES CLAVATUS, n. s. (Plate B, Fig. 5.)

Body elongated, clavate, having its greatest diameter at the apex of the ambulacral field. Pelvis rather small, cup-shaped. Fork pieces long; incision for the reception of ambulacral field as long as the base portion below, so that the distance from the apex of ambulacral field to the base of pelvis is $\frac{1}{7}$ more than that of the portion above. Deltoid pieces very small, externally not visible, and their acute angles do not reach the summit; so that the ambulacral fields at the summit will join each other for a distance of about $\frac{1}{16}$ of an inch. The general shape of the upper part of the calyx is a nice oval, whereas the lower portion assumes a triangular shape, due to the flattening at the base of three fork pieces in their median line. Ambulacral fields moderately wide, and about as long as $\frac{3}{7}$ of the entire length of the body. Lancet pieces half as wide as the ambulacral field. Poral pieces large, amounting to 7 in $\frac{1}{10}$ of an inch. Mouth central, round; the ovo spiracle apertures somewhat closely arranged, and rather large for the size of the specimen. Articulating surface for the column large and round, measuring $\frac{1}{8}$ of an inch in diameter.

Entire length of specimen $1\frac{1}{4}$ inches, greatest transverse diameter $\frac{9}{16}$ of an inch.

Surface apparently not ornamented.

Geological formation and locality—In the Kaskaskia limestone: Evansville, Illinois, rare.

PENTREMITES HEMISPHERICUS, n. s. (Plate B, Fig. 7.)

Body large, hemispherical. Pelvis large, forming a shallow cup and occupying nearly $\frac{1}{2}$ the width of the body; pieces forming the same convex in the centre, giving the cup three longitudinal depressions parallel to the sutures. Fork pieces large; base portion of same horizontal, forming almost a rectangle with the vertical diameter of the body; upper portion sloping gently from the margin of the ambulacral areas to the separating sutures of the adjoining fork piece, giving thus a more even surface to the interambulacral space. Deltoid pieces large, $\frac{1}{3}$ the entire length of the body, and not reaching the summit for the distance of about 3 or 4 poral pieces. Ambulacral fields broad and slightly depressed in the centre, but for each half a rather convex surface. Lancet pieces a little more than $\frac{1}{2}$ of the width of the ambulacral field. Poral pieces rather thick, numbering 8 to $\frac{1}{10}$ of an inch. All apertures on the summit large and closely arranged. The whole surface of the body is very distinctly ornamented with little furrows running parallel to the sutures.

Dimensions—Vertical height as well as transverse diameter, i.e. a little above the apex of the ambulacral field, $1\frac{1}{16}$ inches; vertical distance from centre of pelvis to apex of ambulacral areas $\frac{5}{16}$ of an inch, length of ambulacral field $1\frac{1}{16}$ of an inch, width of same $\frac{5}{16}$ of an inch.

Geological formation and locality—In the Kaskaskia limestone: common at Chester, but rare at Evansville, Illinois.

This species resembles very much, at first glance, *Pentremites robustus* of Lyon, but differs in the smaller number of poral pieces, which are 101 in $1\frac{1}{10}$ of an inch of "Lyon's" species, whereas in the one under consideration there are only 88 in the same space.

PENTREMITES CHESTERIENSIS, n. s. (Plate B, Fig. 8.)

This species seems to be a variety of either *robustus* or *hemisphericus*, but it appears so frequently under the same dimensions that I do not hesitate to regard it as a separate species from any of the foregoing. Its body is oval. Pelvis as large as $\frac{1}{2}$ the transverse diameter, forming a little cup. Fork pieces long; the base portion slopes abruptly, whereas the upper parts slope gently to the sutures of the adjoining pieces, giving thus to the interambulacral fields an almost even surface, or one very slightly depressed. Deltoid pieces lanceolate and as long as $\frac{1}{3}$ of the entire length of the body, projecting with their acute angles slightly above the apertures on the summit. Ambulacral areas as long as $\frac{3}{4}$ of the vertical diameter, narrow and depressed in the centre. Lancet pieces $\frac{1}{2}$ as wide as the ambulacral field. Poral pieces large, numbering 6 to $\frac{1}{10}$ of an inch. Apertures on the summit small and closely arranged. Surface ornamented with very fine striæ.

Dimensions—Vertical height $1\frac{3}{20}$ inches, transverse diameter $\frac{8}{10}$ of an inch, length of ambulacral field $\frac{9}{10}$ of an inch, width $\frac{2}{10}$ of an inch.

Geological formation and locality—In the Kaskaskia limestone of Randolph county and at Chester, Illinois.

I received this fine specimen through the kindness of Miss Colby, and collected it afterwards in a number of specimens at Chester, Illinois.

It differs from *Pentremites robustus* and *hemisphericus* in being longer than it is wide; in having the ambulacral field smaller and depressed, and the poral pieces less in number.

PENTREMITES BROADHEADI, n. s. (Plate — Fig. 6.)

Body subovoid. Pelvis large and prominent, forming a very projecting pentangular disc, with five plainly marked surfaces converging at the centre. Fork pieces large and heavy; base portion flattened, forming with the corresponding part of the pelvis a lanceolate surface, giving the base an appearance of a 5-sepaled calyx with a projecting crest in the centre of each sepal; upper portion sloping abruptly from the margin of the ambulacral areas to the separating suture of the adjoining fork piece, thus giving to the interambulacral space a very depressed arrow-head shape. Deltoid pieces small, lanceolate; their upper acute rostrum projecting above the summit about $\frac{1}{16}$ of an inch. Ambulacral areas very broad and very depressed in the centre. Lancet pieces occupying half the field, and concave in a transverse section. Poral pieces thin, counting 9 to $\frac{1}{10}$ of an inch. All apertures on the summit rather small and closely arranged. Surface of the whole calyx smooth and not ornamented.

Dimensions—Vertical height from the acute rostrum of the deltoid piece to the centre of the pelvis $1\frac{1}{4}$ inches; greatest transverse diameter a little above the apex of the ambulacral field $1\frac{3}{16}$ of an inch; vertical height from apex of ambulacral field to base of pelvis $\frac{7}{16}$ of an inch; width of ambulacral field $\frac{9}{32}$ of an inch, length of same 1 inch.

Geological formation and locality—In the Kaskaskia limestone: Evansville, Illinois, very rare.

I named this beautiful fossil in honor of G. C. Broadhead, late State Geologist of Missouri.

PENTREMITES BASILARIS, n. s. (Plate B, Fig. 9.)

Body large, conoidal. Pelvis about $\frac{1}{2}$ the transverse diameter of the body; slightly cup-shaped in young but more flat and horizontal in adult specimens. Fork pieces a little longer than ½ the entire length of the body; the base portion is horizontal; the prongs sloping from the projecting margin of the ambulacral field very abruptly in their lower portion, but more gently in their upper part towards the sutures of the adjoining pieces, giving thus to the interambulacral space a very depressed triangular surface up to the lower obtuse angle of the deltoid piece, from whence the interambulacral surface becomes level upwards, with two acute points downwards running lateral to the ambulacral fields. Deltoid pieces large, lanceolate, not depressed, and project with their acute rostrum to the summit above the body. Ambulacral fields nearly as long as the body itself, broad and depressed in the centre. Lancet pieces a little more than half the width of the ambulacral field, and concave in transverse section. Poral pieces numbering 8 to $\frac{1}{10}$ of an inch. All apertures on the summit large, but closely arranged. Surface smooth and not ornamented.

Dimensions—Vertical height 1½ inches; greatest width a little above the apex of the ambulacral field, nearly the same.

Geological formation and locality — Kaskaskia limestone: Evansville, Chester, and other places in Illinois, not very abundant.

This species is one of the largest of its kind, and often reaches the size of nearly 2 inches. It much resembles *Pentremites sulcatus*, but has a more horizontal base, is longer, and also more conoidal. It differs from *P. Missouriensis* (Swallow) in having a smooth surface as well as in the acute projecting rostrum of the deltoid piece.

EXPLANATION OF PLATE *A*.

Fig. 1. Pelvis of *Pentremites sulcatus*.

Fig. 2. Section of fork piece of *P. sulcatus* showing the ledges to which the poral pieces are attached.

Fig. 3. Transverse section of *P. sulcatus* just below the apex of the ambulacral field.

Fig. 4. External surface of deltoid piece.

Fig. 5 *a*. Side view of deltoid piece showing the furrows in which the plicas rest.

Fig. 5 *b*. Side view of deltoid piece showing (*a*) lateral expansion, (*b*) base portion of same.

Fig. 6. Transverse section of ambulacral field: (*a*) lancet piece, (*b*) poral pieces, (*c*) prongs of fork pieces, (*d*) zig-zag plicated integument.

Fig. 7. Surface view of the ambulacral field: (*a*) lancet piece, (*b*) poral pieces, (*c*) poral openings.

Fig. 8. Summit of *P. sulcatus* slightly ground to show connections of deltoid pieces, ambulacral field, and ovarian openings: (*a*) deltoid piece, (*b*) ambulacral field, (*c*) ovo-spiracle aperture.

Fig. 9. Oblique section of fork piece and ambulacral field: (*a*) fork piece, (*b*) hydrospiric plicas, (*c*) ovi-duct, (*d*) canal beneath the lancet piece, (*e*) perforation of lancet piece, (*f*) poral pieces, (*g*) lancet piece, (*h*) plicated zig-zag integument.

Fig. 10. Summit of *P. sulcatus*, not ground.

Fig. 11. Ventral surface of calyx, composed of pelvis and fork pieces.

Fig. 12. Dorsal surface of calyx, composed of lancet pieces and deltoid pieces.

Fig. 13. Diagram of a pentremite showing the relation of the pieces at the summit: (*a*) fork piece, (*b*) deltoid piece, (*c*) lancet piece, (*e*) poral piece.

Fig. 14. Interior view of fork piece and ambulacral field, showing the longitudinal furrow of the lancet piece.

Fig. 15. External view of zig-zag plicated integument.

Fig. 16. Interior view of ambulacral field.

Fig. 17. Vertical section through the calyx of *P. sulcatus* showing the thickness of the plates.

EXPLANATION OF PLATE *B*.

Fig. 1. *Pentremites spinosus.*

Fig. 2. *Pentremites nodosus.*

Fig. 3. *Pentremites abbreviatus.*

Fig. 4. *Pentremites Potteri.*

Fig. 5. *Pentremites clavatus.*

Fig. 6. *Pentremites Broadheadi.*

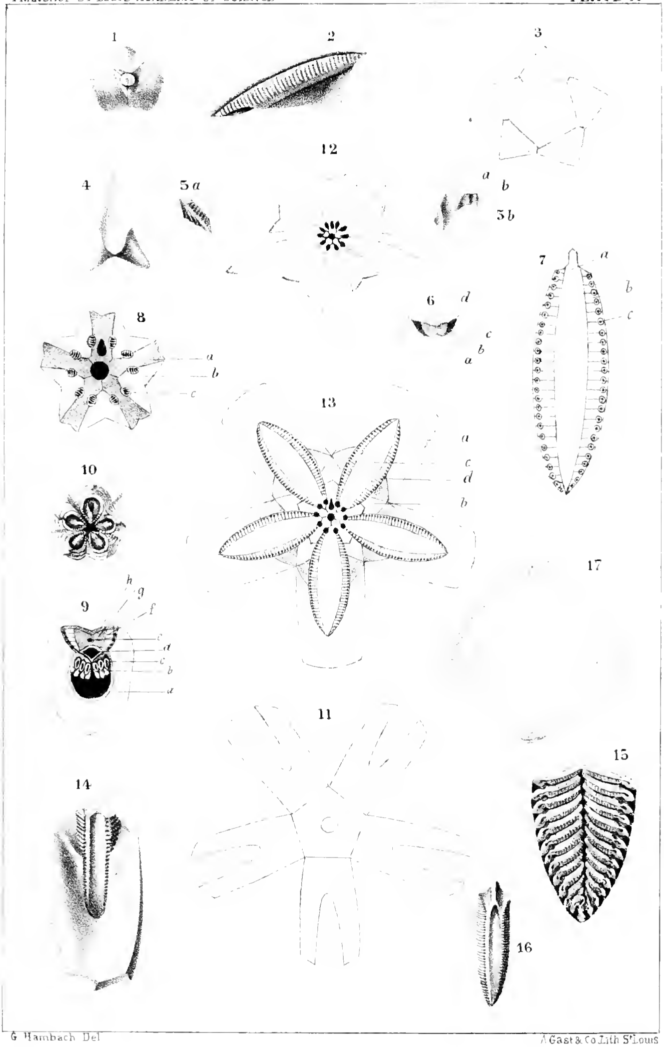
Fig. 7. *Pentremites hemisphericus.*

Fig. 8. *Pentremites Chestriensis.*

Fig. 9. *Pentremites basilaris.*

Fig. 10. *Pentremites sulcatus*, showing cast of *laterniformis.*

Fig. 11. *Pentremites sulcatus* — abnormal in having a longitudinal piece inserted between two fork pieces.



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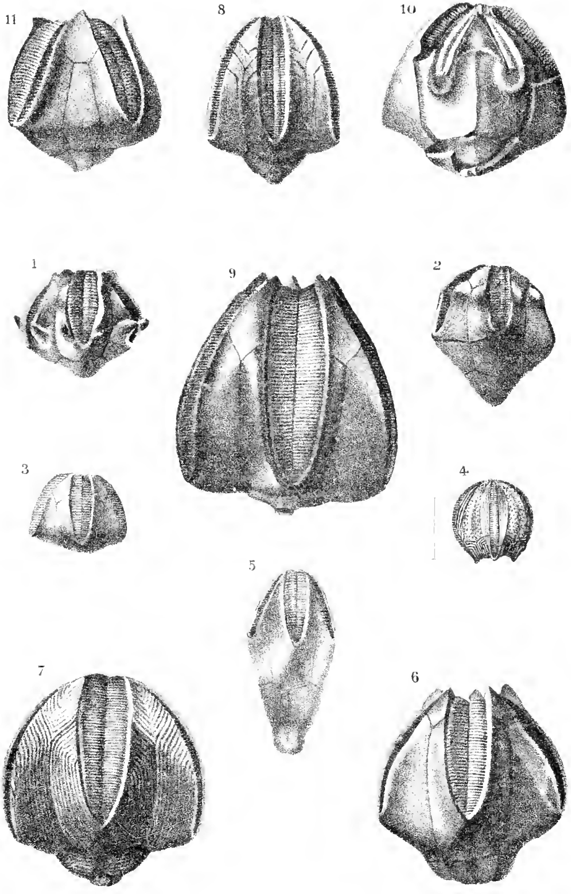

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Revision of the Genus PINUS, *and Description of* PINUS ELLIOTTII.

BY DR. GEORGE ENGELMANN.

No difficulty exists in the circumscription of the genus *Pinus;* floral unite with vegetative characters to establish it so firmly and so plainly, that nobody fails to recognize the species belonging to it. But when we come to analyze and to group the 60 or 70 species of pines which are known to us, we find that they appear so similar, that all attempts to arrange them satisfactorily have failed. The most obvious distinctive character was found in the number of leaves in each bundle, and thus the sections of 2-leaved, 3-leaved and 5-leaved pines were the only ones known to the older botanists. Spach (Syst. veg. 1834) separated *Cembra* on account of its "wingless" seeds; Link (Linnæa, 1841) relied on the number of leaves only, adding two sections, one with 2 or 3, the other with 3 or 4 leaves in a sheath; Endlicher (Synopsis, 1847) was the first to point out the form of the cone-scales as an important character, and his first two sections *Cembra* and *Strobus*, were by the form of this scale distinguished from the other Pines; he retained the character of the "large wingless" seeds, to separate by it *Cembra* from *Strobus*, and *Pinea* from the other two-leaved pines which constituted his section *Pinaster*. Later writers did not add anything to our knowledge of the systematic relations of pines: Carrière (Conifères, 1855) copied Endlicher, and Gordon (Pinetum, 1858) went back to the mere number of leaves to characterize the sections. Ten years later Parlatore (DeCand. Prod. 16^2, 1868) followed Endlicher in adopting the differences in the form of cone-scales as the most valuable character, and advanced a step further by discarding the proportionate size of the seeds as of sectional value. He divided his subgenus *Pinus* in two sections, *Pinea* with pyramidate and *Cembra* with dimidiate apophyses. The subsections of his *Pinea* were again based on the number of leaves, in twos, in threes, or in fives in each bundle; those with single leaves, with 2 or 3, and those with 3, 4 or 5 leaves had to find their place as best they could.

Not satisfied with such superficial knowledge of this interesting and important genus of trees, I have for a number of years devoted my leisure hours to the careful study of the different species accessible to me. In the following pages I give the principal results of my investigations.

SIZE. Almost all the pine species grow up to be trees; the only shrubby one known to me is *Pinus montana*, heretofore known as *P. Pumilio*: a few make small, insignificant trees, such as *P. tuberculata*; the nut-pines, or cembroid pines, never grow large, but several others attain the greatest dimensions; *P. Lambertiana* grows to the height of 300 feet, with 20 feet in diameter, and *P. ponderosa* (at least in California) comes very near it; these two are probably the largest pines known.

The AGE of pines varies between 15 to 25 years (*P. tuberculata* and perhaps *P. montana*), 300 years (*P. mitis*, *P. ponderosa*, *P. Balfouriana*), and 500 to 600 years (observed in *P. monticola* and *P. Lambertiana*.

The BARK in some species is thin, only a few lines thick, flaky and detached in scales (*P. contorta*, *P. resinosa*); in others (e.g. *P. ponderosa*) it is several inches thick, persistent, rough, and deeply cracked. It is gray in some species, e.g. in the nut-pines, but most commonly of a brown red or cinnamon color, or sometimes deeper brown; in *P. australis* and *P. Elliottii*, especially in the latter, it is laminated, the external layers peeling off in thin plates.

The WOOD grows rapidly, especially during the first (often the first 50) years of their age, so that annual rings are sometimes 2 or 3 lines thick; in *P. glabra* I have seen them even 6, in *P. insignis* 5 and in *P. rigida* var. *serotina* 4 lines thick; in old age or in the short seasons of high altitudes the wood grows so slow that sometimes ten annual rings make not more than the thickness of one line.

The sapwood is always white, and it takes many years before it turns into perfect or heartwood: in *P. ponderosa*, *Lambertiana*, and *mitis* sometimes 100 or even 150 years; in others, e.g. *P. flexilis* and *Sabiana* not more than 20 or 30 years: but the majority of pines which I have examined may require 50 or 60 years to mature their heartwood. In many other trees this process takes about 20 or 30 years, in most oaks on an average about 20 years, in *Catalpa* not more than 2 or 3 years. The thickness of the sapwood in pines is usually 2–4 inches, and rarely under 1 inch; in *P. ponderosa* I have found it sometimes even 10 inches.

The wood cells and especially those more compact ones of the late summer growth, the outer part of the layers, are often strongly impregnated with resin and thereby darker colored, yellowish or brown, and become in thin sections semi-transparent; this is much more the case in those of the section *Pinaster* than of *Strobus*. The former have mostly heavier and harder wood than the latter, though we find exceptions, such as *P. contorta*, which has soft wood similar to that of the white pine or spruce. Spirally marked cells, such as abound in *Pseudotsuga* and in *Taxus*, have not been found in the pines.

The LEAVES, in the wider sense, are of seven different forms: the cotyledonous or seed-leaves, the primary leaves, the ordinary bracts, the secondary leaves, the bracts constituting the sheath of these, the bracts forming the involucrum of the male flowers, and the bracts supporting the carpellary scale.

The COTYLEDONOUS LEAVES form a whorl of 4 to 18 in number, are triangular, flat on the back, keeled above, higher than broad and mostly entire; in *P. Strobus* I find the keel slightly spinulose-dentate. Stomata are found only on the inner and upper sides, as is the case in the cotyledonous leaves of most conifers; those of *Sciadopitys* are, as far as I know, the only ones that have stomata merely on the under and none on the upper side.

The PRIMARY LEAVES succeed the cotyledons on the main axis; in some species (*P. inops*, *P. rigida*, *P. Canariensis*, etc.) they are also found on the sprouts. They are always subulate from a broader base, flat, keeled on both surfaces, always serrulate, even in those species whose secondary leaves are entire (*P. edulis*), with stomata in rows on both surfaces, more on the lower than on the upper face.

The primary leaves not rarely produce in their axils buds with secondary leaves, but they are most generally reduced to BRACTS (*Hochblaetter*) before their axils become productive. These bracts are triangular-lanceolate, membranaceous or coriaceous, entire or mostly fringed on the edges, more or less persistent or mostly deciduous, sometimes articulated above their base.

The SECONDARY LEAVES constitute the foliage of the tree: they are borne on an undeveloped branchlet in the axils of primary leaves or mostly of bracts, and are surrounded at base by a sheath of bud-scales (*Nieder blaetter*). These consist of 2 short, rigid, strongly keeled, lateral bracts and a number (6–10 or more) of longer, thinner inner ones, which generally are woven together by the delicate fringes of their edges, and are then persistent with the leaves, though in time worn off at the ends; or they are loose, at last spreading and deciduous at the end of the first season. This is the case in all the species of the section *Strobus*, in the nut-pines, and in a few others: *P. Balfouriana*, *Gerardiana*, *Bungeana*, *Chihuahuana*, and usually also in *P. leiophylla*.

The secondary leaves generally occur in definite numbers, 1 to 5, in a bunch, or their number is slightly variable: some species have regularly 2 and 3 leaves (*P. mitis*, *P. Elliottii*), others vary with 3 to 5 leaves (*P. Montezumæ*); species with regularly 3 leaves have occasionally 2 or 4, such with 5 leaves are sometimes found with 6 and even 7 leaves. Where we have one (only in *P. monophylla*), the leaf is terete; where there are two, the leaves are semi-terete, convex on the lower surface and flat on the upper one when fresh, or channelled when dry. Those leaves that grow in bundles of 3 or more are triangular, the upper surface being more or less elevated and keeled; ternate leaves are generally somewhat flatter, and quinate ones higher and regularly triangular. Thus the shape of the leaf and especially its transverse section is mostly sufficient to determine the number in which they occur.

The leaves are in most species minutely but sharply serrulate on the edges, and mostly also on the keel of the upper surface. These serratures are closer together, or more distant, coarser or more delicate, but are absent only in a very few West-American species: the *cembroid* or nut-pines, *P. Balfouriana*, and most forms of *P. flexilis*. The tips of the leaves are generally entire, acute, or acuminate, rarely obtusish; but in all the species of the section *Strobus* they are in the young and fresh leaves finely denticulate.

The stomata are usually distributed in longitudinal rows over both surfaces in the *Pinaster* section; only *P. Balfouriana* has none on the back, and thus approaches *Strobus* in this as it does in many other respects. In *Strobus* we find on the back no or but few stomata, or sometimes a single or an interrupted line of them. *P. Lambertiana* only has numerous stomata on the back, thus approaching *Pinaster*.

I will have to dwell somewhat extensively on the internal structure of the leaves, as it proves to be of the greatest importance for the classification of the species. We distinguish in a transverse section the thick epidermis, the chlorophyll-bearing parenchyma cells, and in the centre the fibro-vascular bundle. This latter is single in the terete and mostly in the quinate leaves; it is double in the broader triangular or ternate, and in the semi-terete or binate leaves. This difference, however, is of very little diagnostic importance, as we find occasionally single or double bundles in the same species. The fibro-vascular bundles always show wood cells on the upper or ventral, and bast cells on the lower or dorsal side, traversed by delicate medullary rays, usually obliquely diverging from the lower to the upper side. The bundles are imbedded in a mass of small (medullary?) cells, free of chlorophyll, and are together with those surrounded and separated from the parenchyma by a sheath of larger cells, also destitute of chlorophyll.

Within the parenchyma of the leaf a smaller or larger number of longitudinal tubes or ducts are found, the RESIN DUCTS, normally probably two, but very often more, even as many as a dozen or more. These ducts occupy a certain definite position within the leaf They lie (1) close to the epidermis, *peripheral ducts*, in some species more on the ventral, in others more on the dorsal side of the leaf; or (2) they occupy a place within the parenchyma and surrrounded by it on all sides, *parenchymatous ducts;* or (3) they lie close to the sheath which surrounds the vascular bundles, *internal ducts*. This position of the ducts is so constant, and seems to be so intimately connected with the essential character of the plant, that I venture to adopt it as one of the principal characters for the subdivision of the genus. I must add, however, that in some few species smaller, accessory ducts do sometimes occupy an abnormal position. Thus I find occasionally in some *Strobi*, especially in *P. excelsa*, where there are mostly two peripheral dorsal ducts, a third upper parenchymatous one; in *P. Bungeana*, which generally has numerous peripheral ducts all around, occasionally a single lateral parenchymatous duct is observed; *P. Canariensis* has regularly parenchymatous ducts, but sometimes they are connected with the epidermis by a very thick bundle of strengthening cells (of which presently); *P. Laricio* has normally parenchymatous ducts, but in a specimen of var. *Pyrenaica* from the Pyrenees in Herb. Cosson I find them sometimes almost touching the epidermis cells, and therefore easily mistaken for peripheral. In *P. rigida* and *Tæda*, and also in *P. pungens* and *filifolia*, which all have normally parenchymatous ducts, I occasionally have observed a number of smaller accessory ducts close to the sheath of the vessels. In pines with very slender leaves it is sometimes difficult to discover the ducts, and in some forms they are, I believe, really absent, especially in cultivated specimens. Such may give us some trouble in their classification.

A peculiar element in the structure of the pine leaves are certain cells which had been formerly named "hypoderm cells"; but as they also occur in other parts of the leaf apart from the epidermis, they more appropriately receive the name of STRENGTHENING CELLS. They are thick-walled, elongated, colorless cells, much larger than the bast and wood cells, generally of the diameter of the epidermis cells, rarely a little larger, often smaller, and always smaller than the cells of the parenchyma. They give to the leaf its rigidity, and are most abundant in the most rigid pine leaves; in the softer more flaccid ones they are almost entirely wanting. Thus they are scarce or entirely absent in some species of the *Strobus* section; in *P. Pseudostrobus* and *P. filifolia* they are very imperfectly developed. The strengthening cells are principally found under and close to the epidermis (whence the name hypoderm cells) either in a continuous layer or mostly in bundles, interrupted by the lines of stomata; they are generally most abundant within the angles of the leaves. Sometimes they surround the ducts, and in all the species allied to *P. resinosa* and *P. sylvestris* they are found only there, and not or scarcely at any other places. In some species these cells also occur within the sheath, above and below the fibro-vascular bundles. Their presence and position is not absolutely constant, but may be relied on to some extent for diagnostic purposes. Thus the quinate smooth-edged leaves of *P. flexilis* and *P. Balfouriana*, which would be difficult to distinguish without their cones, may be readily recognized by the strengthening cells, which in the latter surround the more closely approximating ducts, while in the former the ducts, widely apart from one another, are destitute of these cells.

The PERSISTENCE of the leaves is very different in different species; in *P. Strobus* and others they fall in the autumn of the second year: more commonly they last to the end of the third year; in some species, e.g. *P. Banksiana*, they do not fall before they are 4, 5 or even 6 years old: in *P. Balfouriana*, or at least in var. *aristata*, I have seen them persist 12 to 14 years. When the leaves persist only a short time and are long, and the annual growth of the axis is short, they form brushes or tassels (*P. australis*) at the end of the branchlets, but where they are short and persist long (*P. Balfouriana*) they give the branchlets that "fox-tail or bottle-brush" appearance of which travellers speak. In young and vigorous trees the leaves are apt to persist longer than in old ones.

In exceptional cases and as a monstrosity the leaf-bundles become proliferous, the branchlet which bears the secondary leaves elongating and forming a regular branch.

The pines are monœcious trees which bear their male and female flowers generally on different branchlets, the male commonly on the lower, the female frequently on the upper part of the tree; sometimes both are found on the same axis, the male below, the female above.

The MALE FLOWERS are borne on the lowest part of the year's shoot, in the axil of bracts, either crowded together in a kind of a head or elongated in a spike; the axis usually continues to elongate during or after flowering and makes a leafy branch, which in its continuation in succeeding years often again bears flowers. Male flowers sometimes abnormally make their appearance higher up on the axis mixed with leaf-bundles and occupying the place of such. The male flowers consist of an indefinite number of anthers sessile on a more or less elongated column, and have the form of an oval or a cylindrical ament, for which they used to be taken. They are surrounded by a somewhat definite number of bracts, which assume the functions of a calyx and have been sometimes designated as such. Linnæus, in his Syst. Nat. ed. 1, speaks of a *calyx 4-phyllus*. Their number varies in the different species from 3 to 15 or 16, but is fairly constant in the same species. The two exterior lateral bracts are strongly keeled, like those of the sheath of the leaves, and stouter and mostly shorter than the others; the third is placed on the upper side, towards the axis of the inflorescence; the fourth on the lower or dorsal side, opposite the supporting bract, and so forth. The innermost ones not rarely exhibit a transition to the anthers, bearing small or incomplete anther cells on the lower part of their back. In *P. resinosa* and *Canariensis* I find the involucral bracts articulated in the middle.

A table exhibiting the numerical proportion of involucral bracts in the different species, the male flowers of which I could examine, may not be without value.

3 or 4 involucral bracts I find in *P. sylvestris* and *Pinaster:*
3 to 6 in *P. densiflora;*
4 in *P. Balfouriana*, *Canariensis*, and *Greggii;*
4 to 5 in *P. edulis* and *Parryana;*
4 to 6 in *P. Pinea* and *P. Halepensis;*
4 to 10 in *P. Pyrenaica;*
5 to 6 in *P. monophylla;*
6 in *P. leiophylla*, *Laricio*, and *contorta:*
6 to 7 in *P. resinosa*, *montana*, and *Massoniana;*
6 to 8 in *P. Strobus*, *excelsa*, *Peuce*, *Cembra*, *rigida*, *tuberculata*, *muricata*, *pungens*, *Banksiana;*
8 to 10 in *P. monticola*, *flexilis*. *insularis*, *Chihuahuana*, *Thunbergii*, *Laricio* var. *Pyrenaica*, and *Austriaca*, *Coulteri*, *inops:*
8 to 12 in *P. Tæda:*
9 to 12 in *P Montezumæ* and *mitis;*
10 in *P. insignis:*
10 to 12 in *P. ponderosa;*
10 to 15 in *P. Sabiniana;*
12 in *P. Merkusii* and *Elliotti:*
12 to 14 in *P. Khasia*, *glabra*, and *australis;*
14 to 16 in *P. Lambertiana* and *Cubensis*.

The ANTHERS consist of two parallel extrorse cells, which open longitudinally on their back; their connective, heretofore often called a bract, spreads out into a transverse semi-orbicular or almost orbicular, entire or denticulate (in most species of *Pin-*

aster) or lacerate (*P. Lambertiana*) crest, or it terminates in a knob or a few teeth (in most *Strobi* and a few *Pinasters* such as *P. Balfouriana* and *sylvestris*).

The POLLEN has the well known bilobed form, consisting of an elliptic central portion, which emits the pollen tubes, and two lateral sacs which are said to contain air. The longer diameter measures 0.025 to 0.045 lines, mostly between 0.030 and 0.040 lines, while the pollen grains of *Abies* and *Picea* are much larger and in many instances twice as large, viz. 0.045 to 0.070 lines long. Thus by the pollen alone *Pinus* can generally be distinguished from those allied genera. The different species of pines are pretty constant in the size of their pollen.

Without going into minute detail, I will only state that I find pollen grains of

0.025–0.030 lines in *P. edulis* and *P. Banksiana*:
0.030–0.035 " in *P. Balfouriana*, *sylvestris*, *montana*, *resinosa*, *Chihuahuana*, *Laricio*, *inops*, *contorta*;
0.035–0.040 " in *P. Strobus*, *excelsa*, *Pinea*, *rigida*, *Tæda*, *mitis*.
0.040–0.045 " in *P. Lambertiana*, *flexilis*, *Montezumæ*, *Pinaster*, *ponderosa*, *Sabiniana*, *Elliottii*.

The property of the pine-pollen to float for a long time in the air, and to be carried by storms to very distant localities, is well known. I have found in streets of St. Louis after a rainstorm from the south, in March when no pines north of Louisiana were in bloom, pine-pollen which must have come from the forests of *P. australis* on Red river, a distance of about 6½ degrees of latitude or 400 miles in a direct line.

The FEMALE FLOWER consists, as in all *Abietineæ*, of a carpellary scale in the axil of a smaller, concealed, bract, bearing two pendulous ovules on the lower part of the upper side. A number of such scales in the axils of their supporting bracts, and spirally arranged, form the female ament. The question of the nature of the scales, and of the ovules they bear, is not to be discussed here, but it may be stated that the best lights force the view on us that the carpellary scale consists morphologically of two leaf-organs, lateral to an undeveloped axis and united at their posterior edges (those turned towards the axis of the ament), and thus bearing their naked ovules on their morphologically outer but now reversed and *apparently* upper side.

The carpellary scales, which in the flower as well as in the fruit we call, in short, *scales*, are either rounded, obtuse, and appressed (in *Strobus*, etc.), or they have a short (*P. resinosa*, *sylvestris*, etc.) or a longer (*P. ponderosa*, *Tæda*) or an elongated subulate, often squarrose, point (*P. contorta*, *inops*, *pungens*).

The aments are globose, oval or elongated, subsessile or peduncled, single or several together, always erect, each borne in the axil of a bract, its base invested by sterile bracts which gradually or suddenly give place to the carpel-bearing bracts, just as the involucral scales of the male flowers give place to stamens. They make their appearance on the upper part of the year's shoot, often just below the terminal bud, when we call them *subterminal;* or they become *lateral*, when the axis elongates beyond them, and sometimes more aments form above them in the same season. The axis above the aments continues covered with leaf-bundles in some, while in others it is naked for some distance, or rather destitute of leaves, bearing only bracts; a second stage of aments or the terminal bud is always preceded by a number of leaf-bundles.

The position of the female ament, whether subterminal or lateral, seems to be connected with an essential difference in the species of pines, secondary in importance only to the leaf structure as described above, and both of these together will enable us to arrange the species in something like a natural order. It ought to be understood, however, that the relative position of the ament on the axis is not absolute and that variations do occur. Species with ordinarily subterminal aments may in young and vigorous shoots sometimes bear lateral aments; this occurs, though very rarely, in *P. ponderosa* and *australis*, and perhaps in others, but I have never seen it in any of the *Strobus* section, nor in *P. sylvestris*, *resinosa*, *Laricio* or its allies. More frequently subterminal aments are found in species which normally bear lateral ones, probably when with the formation of the aments the vigor of the axial growth has been exhausted; thus sometimes a second stage of aments is subterminal, while the first is of course lateral; or subterminal and lateral ones are occasionally found on different branches of the same tree; or, very rarely, a tree bears almost entirely subterminal aments. This last case I have seen in the Californian *P. muricata* and in the Mediterranean *P. Pyrenaica*. This character has to be studied intelligently among the native trees in their homes. So long as only a few herbarium specimens can be consulted it must remain doubtful, and errors may creep in, especially as collectors have heretofore paid so little attention to the necessity of obtaining instructive specimens, which, however, are easily procured in any season of the year, provided the tree bears at all; for always either flowers or young cones, or in spring both together, can be obtained.

The compound FRUIT resulting from these aments, known as the *cone* or *strobile*, matures at the end of the second, or in a single species, *P. Pinea*, of the third season; during the first twelve months it does not enlarge much; in most species it retains its erect position during that period, but in a few it becomes reversed soon after flowering and before the leaves are developed (*P. sylvestris* and *Elliottii*); in the allies of *P. Strobus* the slender peduncle bends downwards in the second summer apparently by the weight of the swelling cone; but in the majority of the species the cones in that period assume a horizontal or somewhat declined, rarely a strictly recurved, position. Only in *P. Banksiana* it is as often curved upwards as horizontal. We continue to speak of subterminal and of lateral cones in regard to that part of the axis which bore the flowers, though the branch elongates in the next year, and the maturing cone, strictly speaking, thus always becomes lateral.

The cones are, as the name might indicate, conical, from subglobose to oval or subcylindrical, mostly more or less symmetrical, often slightly oblique, and in some Californian and Mexican species (*P. insignis, tuberculata, muricata, patula*) so much so, that the scales on the inner and the outer side become very unequal; in the first named species especially we find the scales on the outer, convex, side much larger and tumid; on the inner, more flat, side smaller and depressed, but singularly enough more fertile than the big outer ones. The color of the cones is from gray to light leather-brown, reddish, or deep brown, with a dull or a glossy or almost varnished surface. They vary in length from 1½ or 2 to 12 or even, in *P. Lambertiana*, to 18 inches.

The phyllotactic arrangement of the scales is quite interesting, but not of much diagnostic importance; nevertheless it will be necessary in the description of the different species to mention it, and also to state the number of the more prominent secondary spirals, two of which, inclining in opposite directions, are always the most conspicuous. The long cones of *P. Strobus*, *excelsa* and *Ayacahuite*, and the short ones of *P. edulis* and *monophylla*, show the $\frac{8}{13}$ order of scales, and the 3 and 5 spirals are the most prominent ones. *P. Lambertiana* and *Sabiniana* have the $\frac{34}{55}$ arrangement with the 8 and 13 or the 13 and 21 spirals most conspicuous. The intermediate orders of $\frac{13}{21}$ and $\frac{21}{34}$ are the most common ones; abnormal orders are extremely rare.

The cone scales furnish us the most valuable characters for the classification of the species. Their exposed part, not covered by adjoining scales and more or less thickened, has been called the *apophysis;* it is rather depressed and terminates in a blunt point in the section *Strobus;* in *Pinaster* it bears its point on the usually more thickened back, the *umbo*, mostly armed with a prickle, weak or strong, early deciduous (in *P. Balfouriana*, *insignis*, *Banksiana*) or stout and persistent (in *P. rigida*, *Tæda*, *inops*, *pungens*); in some species (*P. Sabiniana*, *Coulteri*) it becomes a thick, long, and often curved or twisted spur.

The bracts which support the scales remain concealed, but become greatly enlarged and mostly thickened and corky, and help to form lodges for the seeds, which are enclosed between them and the scales.

The cones generally open their scales soon after maturity, drop their seeds, and fall off soon afterwards; in most cases they separate at the insertion of the peduncle, but in a few instances (*P. ponderosa*, *P. australis*) the peduncle and the lowest part of the axis together with a number of scales remain on the branch. In some species (*P. Sabiniana*, *Coulteri*) the open cones persist for several years on the tree, and in others they remain almost indefinitely, so that they are apt at last to be partially enclosed in later layers of wood. Such are *P. Banksiana*, *inops*, *pungens*, *insignis*, *muricata*, *rigida*, and some Mexican species. Most specimens of *Pinus contorta* retain their cones in this manner, while those of the higher sierras of California are early deciduous, proving that this character is not of great specific importance. The persistence of the cones may be connected with the peculiarity of some species to retain their seeds in temporarily or permanently closed cones, when they are called *serotinous.* Such are southern forms of *P. rigida* (var. *serotina*) and *P. inops* (var. *clausa*), rarely *P. Tæda*; in some Californian (*P. insignis, tuberculata, muricata*) and Mexican species (*P. patula. Teocote* and *Greggii*) this is still more conspicuous. The seeds of such serotinous cones seem to retain their germinating power for many years longer than loose pine seeds, which are known soon to lose their vitality.*

The SEEDS are obovate, or often more or less obliquely triangular, rarely (in *P. Sabiniana* and *Gerardiana*) nearly cylindrical, generally somewhat compressed, 2 to 12 lines in length, smooth or often on the lower surface ridged or slightly tuberculated, always destitute of balsam vesicles, pale gray or yellowish, or spotted, or brown, and often black. A wing is always present, and is generally several times longer than the seed; in some large-seeded species (*P. flexilis, Cembra, edulis* and the other nut-pines, and *Pinea*) it is reduced to a narrow rim, which is apt to remain attached to the scale when the seed is liberated; in *P. parviflora, Bungeana, Gerardiana, Torreyana,* and *Sabiniana*, it is more conspicuous, but shorter than the seed itself; in *P. Coulteri* it is about as long as the seed, and in *P. Lambertiana* longer. The size of the seed and the proportion of the wing to it has been considered to furnish valuable sectional characters, but it proves to be only of specific importance. The wing is always more or less oblique and widest in some species upwards, in others near the base. The base of the wing forms a rim which surrounds the seed, leaving its under side free and with its edge covering part of, or rarely the greater part (*P. Elliottii*) or the entire upper side (only seen in *P. Banksiana*). Generally the wing and its rim is completely separable from the mature seed, but in a few species (*P. Strobus* and allies) it adheres to it closely, and is at last broken off irregularly.

The COTYLEDONS, 4 or 5 to 15 or 18 in number, are mostly several times shorter than the caulicle, usually not longer than its

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* Seeds from closed cones of *P. contorta*, two to eight years old when I collected them in Colorado, and then kept four years in a hot garret, germinated freely with Prof. Sargent of the Arnold Arboretum, Mass.

diameter, and rarely as long or a little longer than it; this seems to be the case especially where the leaves also are of unusual length, e.g. in *P. australis.*

It is easy enough and very satisfactory to ascertain the number of cotyledons where a large quantity of seedling pines is at one's disposal. With me this was unfortunately not the case; hence I had to examine the seeds themselves, quite a laborious process, rarely extending over more than six or eight specimens, and often less. In examining greater numbers more variation will probably be discovered. As it is, the different species show a tolerable constancy in the number of their cotyledons. I give here only the result of my own observations, leaving out those found in the books. I have observed

about 5 cotyledons in *P. Balfouriana, montana* (3-6), *Laricio, rigida, inops* (4-6), *muricata* (4-5), *glabra* (5-6), *Banksiana* (4-5);

about 6 cotyledons in *P. Balfour.* var. *aristata* (6-8), *resinosa* (6-7), *sylvestris* (6-8), *insignis* (5-8), *tuberculata* (5-8), *Tæda* (5-8), *pungens* (7), *Pinaster* (5-8), *mitis* (4-7);

about 8 cotyledons in *P. Strobus* (7-11), *monticola* (6-9), *parviflora* (8-10), *flexilis* (8-9), *monophylla* (7-10), *edulis* (7-10), *Parryana, Halepensis* (6-9), *ponderosa* (6-11), *Canariensis, australis* (7-10), *Elliottii* (6-9);

about 10 cotyledons in *P. excelsa* (8-12), *Peuce* (9-10), *Cembra* (9-12), *cembroides* (9-12), *Bungeana* (11);

about 12-15 cotyledons in *P. Ayacahuite* (12-14), *Lambertiana* (12-15), *Pinea* (10-14), *Torreyana* (13-14), *Sabiniana* (12-18), *Coulteri* (10-14).

In germination the seed-shell is raised like a hood on the tip of the cotyledons, mostly after the wing has come off, but sometimes the wing is raised high above the plantlet (*P. australis*). The axis generally soon elongates, bearing the primary leaves, but the species just mentioned behaves peculiarly in this period, almost as do many moncotoyledonous trees. For six or eight years it grows not in length but only in thickness, and bears in the axils of the short primary leaves numerous tufts of long and slender secondary leaves, which give the plantlet the appearance of a coarse grass or a rush; only after it has acquired sufficient vigor the thick axis rapidly shoots up.

I now propose an arrangement of the species of *Pinus* based upon the more essential characters above analyzed, and, though I by no means claim it to be a faultless one, I expect that it will deserve the character of a natural one as much as any that can be devised. I find with Endlicher the most valuable character in the fruit scale, or rather, to speak more correctly, I find that the form of the fruit scale in this genus corresponds with a series of other characters which constitute two very natural sections of the genus. My section *Strobus* in a wider sense includes his *Strobus* and *Cembra*, and my *Pinaster*, also enlarged, comprises all his other sections, viz. *Pseudo-strobus*, *Tæda*, *Pinaster*, and *Pinea*. The subsections are distinguished by the position of the ducts within the leaf, whether peripheral, parenchymatous, or internal. Subordinate to this character is the subterminal or lateral position of the female ament and the cone. Only after this may the number of leaves in a sheath be taken into consideration, and perhaps the presence or absence of strengthening cells around the ducts. It will be found that thus not only natural but to some extent even geographical alliances are best preserved. I enumerate only such species or subspecies (these in brackets) which I have been able to examine myself; the list, however, will be found nearly complete. The nomenclature of Parlatore in DC. Prod. xvi.[2] is adopted unless otherwise stated.

Sect. I. STROBUS. Apophysis with a marginal unarmed umbo, generally thinner: cones subterminal; leaves in fives, their sheaths loose and deciduous; anthers terminating in a knob, or a few teeth, or in a short incomplete crest; wood softer, lighter, less resinous.

§ 1. Eustrobi. Ducts peripheral.—Northern or mountain species of the Old and New World.

* Wings longer than the seeds: leaves sharply serrulate, denticulate at tip.

† Strengthening cells few, none around ducts.

P. Strobus, monticola, excelsa. Peuce,[3] *parviflora,*[2] *Bonapartea,*[3] *Ayacahuite.*

†† Strengthening cells abundant under the epidermis and surrounding ducts.

P. Lambertiana.

** Wings much shorter than seeds; leaves mostly entire, not denticulate at tip.

P. flexilis, (*albicaulis,*) *pygmæa.*

§ 2. CEMBRÆ. Ducts parenchymatous; leaves sparingly serrulate, scarcely denticulate at tip.—Europe and principally Asia.

P. Cembra,[4] *Mandschurica*, *Koraiensis*.

Sect. II. PINASTER. Apophysis with a dorsal umbo, mostly armed, generally thicker; leaves 1 to 5 in a bundle, their sheaths usually persistent; anthers mostly terminating in a semi-orbicular or almost orbicular crest; wood generally harder, heavier, and more resinous.

A. Ducts peripheral.

a. Cones subterminal.

§ 3. INTEGRIFOLIÆ. Leaves smooth-edged, their sheaths deciduous; anthers terminating in a knob or a few teeth.— Western North America and Mexico.

* Cones short subglobose, with thick scales, unarmed; seeds large with a minute wing; leaves 1 to 5. *Cembroides*.

P. Parryana, *cembroides*, *edulis*, *monophylla*.[5]

** Cones oval or elongated, scales armed with a deciduous or persistent prickle or an awn, seeds much shorter than the wing, leaves in fives. *Balfouriana*.

P. Balfouriana,[6] (*aristata*).

§ 4. SYLVESTRES. Leaves serrulate, their sheaths persistent; anthers crested or (only in *P. sylvestris*) merely knobbed.—Europe and Asia, one species in America.

* Leaves in threes; wings much longer than seeds.—East India and its islands. *Indicæ*.

P. Khasia,[7] *insularis*,[7] *longifolia*.[7]

** Leaves in twos; strengthening cells abundant, principally around ducts; fructification biennial, cones and seeds small, wings large. *Eusylvestres*.—Old World, one species in Northeastern America.

P. sylvestris,[8] *montana*,[8] *resinosa*,[9] *densiflora*,[10] *Massoniana*,[11] ? *Merkusii*.[12]

*** Leaves in twos; strengthening cells under the epidermis and around ducts; fructification triennial, cones and seeds large, wings rudimentary.—A single Mediterranean species.

P. Pinea.

b. Cones lateral.

§ 5. HALEPENSES.—Old World.

* Leaves in threes, their sheaths deciduous; umbo very prominent; wings shorter than the large seeds. *Gerardianæ*. Asia.

P. Gerardiana,[13] *Bungeana*.

** Leaves in twos, their sheaths persistent; cones smoothish; wings much longer than the seeds. *Euhalepenses*.—Mediterranean regions.

P. Halepensis,[14] *Pyrenaica*.[15]

B. Ducts parenchymatous.

a. Cones subterminal.

§ 6. PONDEROSÆ.—Mostly American, with three Old World species.

* Leaves in fives, ducts usually free of strengthening cells. *Pseudostrobi*.—Central America and Mexico to Arizona and California.

P. leiophylla,[16] *tenuifolia*, *filifolia*,[17] *Pseudo-Strobus*, *Montezumæ*[18] (*Hartwegii*), *Torreyana*,[19] *Arizonica*.[20]

** Leaves in threes, sometimes in fours or fives, their sheaths persistent; strengthening cells under the epidermis, around ducts, and usually also near the fibro-vascular bundles.—*Eupondcrosæ*.—Northwestern America, Mexico, and Canary Islands.

P. Engelmanni,[21] *ponderosa*[22] (*Jeffreyi*), *Canariensis*.[23]

*** Leaves in threes, their sheaths deciduous.—Mexico and Arizona.

P. Chihuahuana.[24]

**** Leaves in twos, generally with some strengthening cells around ducts. *Lariciones*.—Europe to Asia and W. America.

P. Laricio[25] (*Austriaca*), *Thunbergii*,[26] *contorta*[27] (*Murrayana*).

b. Cones lateral.

§ 7. TÆDÆ.—Mostly American, only one Old World species.

* Leaves in threes, ducts mostly without strengthening cells. *Eutædæ*.—North America to Mexico.

P. Sabiniana,[28] *Coulteri*,[28] *insignis*,[29] *tuberculata*,[30] *Tæda*,[31] *rigida*[31] (*serotina*[32]), *Greggii*, *Teocote*, *patula*.[33]

** Leaves in twos; cones with very stout prickles. *Pungentes*.

† Ducts without strengthening cells.—North America.

P. inops (*clausa*[34]), *pungens*,[35] *muricata*.[36]

† † Ducts surrounded by strengthening cells.—Southern Europe.

P. Pinaster.[37]

*** Leaves in twos, or in the first often also in threes; cones with weak or deciduous prickles. *Mites*.—Eastern North America.

P. mitis,[38] *glabra*,[39] *Banksiana*.[40]

C. Ducts internal.

§ 8. AUSTRALES. Leaves in twos to fives; timber very heavy and resinous.—Southeastern North America, West Indies, and one species in Mexico.

* Cones subterminal; leaves in threes to fives. *Euaustrales.*
P. oocarpa,[41] *occidentalis*, *australis*.[42]

** Cones lateral or mostly so; leaves in twos to threes. *Elliottiæ.*

P. Elliottii,[43] *Cubensis*,[44] *Wrightii*.[45]

NOTES.

1. *P. Peuce*, Griseb., may after all be distinct from *P. excelsa*; it has much shorter leaves and sheaths, and, if my specimen can be relied on, a short fruiting peduncle; the structure of the leaf is nearly the same in both. *P. Peuce*, *excelsa*, and *monticola* have a layer of strengthening cells all around under the epidermis, interrupted only by the stomata, and not in distinct bundles as in *Lambertiana* and *Bonapartea*, while *P. Strobus*, *Ayacahuite*, and *parviflora*, have scarcely any. They all have regularly two dorsal ducts only. In *P. excelsa* I have repeatedly found a third, upper, and always a parenchymatous one.

2. *P. parviflora*, Sieb. & Zucc. A branch in Herb. Haenke in the Prague Museum, marked "*P. heteroyhylla*, Presl, Nutka Island," seems to belong to this species, which is distinguished by slender, distantly and very slightly serrulate leaves, and scarcely any strengthening cells.

3. *P. Bonapartea*, Roezl. Prof. E. Purkinje, of the Foresters' Academy of Weiswasser, Bohemia, who was probably the first to carefully study the microscopic anatomy of the pine-leaves with a view to the diagnosis of the species, and who is now publishing the results of his investigations in an extensive and copiously illustrated work, has directed my attention to the leaf-structure of this form. It deviates from all the other *Strobi* in having numerous, usually 7, ducts, 3 on the back and 2 on each of the upper sides, and having strengthening cells in numerous bundles all around and especially in the angles. I find no stomata on the back. Roezl's *P. Don Pedri* has exactly the same structure, but has 3 or 4 series of stomata on the back: both evidently belong together. Though I have not been able to study the flowers and fruit, I do not hesitate to pronounce it distinct from *P. Ayacahuite*, which, like *P. Strobus*, has scarcely any strengthening cells, and only 2 dorsal ducts.

4. *P Cembra*, Lin. The ducts, generally in the middle of the parenchyma, sometimes nearly approach the epidermis, but I have always found them separated from it by at least one layer of parenchymatous cells.

5. *P. monophylla*, Torr. & Frem. The number of ducts is excessively variable; I have found from 3 to 14 in different leaves. The leaves are usually curved, and the upper side, proved to be such by the relative position of the wood and bast cells (see p. 165), is always directed towards the branch. Sometimes two-leaved bundles occur. It is an open question whether the four species of the subsection *Cembroides* may not properly be united into one, as the difference of flowers and fruit is very slight, and that of the foliage only relative.

6. *P. Balfouriana*, Jeffrey, and *P. aristata*, Engelm., of the Colorado Rocky Mountains, are identical in leaf-structure and in flowers and must be united, though the cone of the former is elongated, often even cylindrical, the apophyses thicker and peculiarly spongy, and at maturity unarmed, while the other has an oval cone with thinner scales and awnlike prickles. In Utah and Nevada a form occurs with cones like the latter, but with short, stout, recurved prickles. Parlatore enumerates *aristata*, but does not mention *Balfouriana*.

7. *P. Khasia*, Royle, and its two allies, form a very natural little group. Leaves in this species with 2 dorsal ducts; strengthening cells very slight and only in the corners; male flowers 1 inch long, slender; involucral bracts 12 to 14, exterior half as long as the inner ones, all apparently pointed; anthers $\frac{3}{4}$ to 1 line long; crest only $\frac{1}{2}$ line wide, nearly entire.

P insularis, Endl., has similar leaves, ducts often indistinct, strengthening cells slight in the corners and some scattered under the epidermis and also near the vessels; male flowers 1 inch long; involucral bracts about 8, outer pair more than half as long as the inner ones; anthers less than 1 line long, crest nearly entire.

P. longifolia, Roxb. Ducts few (in Wallich's specimens), or many (in Hooker and Thompson's), or none at all (Hooker's; Thuret's cult.); strengthening cells strongly developed in bundles all around leaf; bracts large, strongly fringed, deciduous; male flowers larger than in last, 1–1$\frac{1}{4}$ inches long, thicker; anthers 1$\frac{1}{2}$ lines long; crest $\frac{3}{4}$ line wide, strongly fringe-denticulate; involucre not seen. The thick bundles of strengthening cells and the larger male flowers readily distinguish it from the two others.

8. *P. montana*, Duroi, is so well characterized that it is inconceivable how it could have been taken for a variety of *P. sylvestris*, unless some hybrid forms, which are said to occur, have created the difficulty. The involucral bracts are always more numerous, usually about 6, the anthers crested, the female aments subsessile, and the young cone erect; in *sylvestris* the involucral bracts rarely exceed 3, the crest of the anthers is reduced to a small ridge or a few teeth, the female ament is not longer than its peduncle and becomes recurved soon after flowering.

9. *P. resinosa*, Ait., is the only American representative of this well characterized group. The 6 involucral scales are articulated in the middle, the upper part falling off early (p. 168); ducts almost always only 2 on the upper side of the leaf.

10. *P. densiflora*, Sieb. & Zucc. Leaves with numerous ducts, mostly surrounded by strengthening cells, also some of these within the sheath; in a few instances, in Japanese as well as in cultivated specimens, the strengthening cells are almost wanting; male flowers oval, only 2 to 3 lines long, in an elongated spike; involucrum of 3 or 4 or rarely 5 or 6 bracts of equal length; anthers only $\frac{1}{2}$ line long, or less, with a small, slightly denticulate crest. Only in Japan. Sometimes cultivated under the name of the following.

11. *P. Massoniana*, Lamb. Parlat., well distinguished from the tree thus named by Siebold & Zuccarini and by Endlicher, which was named by Parlatore *P. Thunbergii* (see note 26). It is similar to the last, but has longer and more slender leaves and is a native of the warmer climate of Southern China, and is not hardy where *densiflora* and *Thunbergii* are. Ducts few or many, often with a few strengthening cells, these cells also in the corners, very few under the epidermis, rarely some with the vessels; male flowers slender, cylindric, 6–8 lines long, in a spike, involucrum of 6 or 7 bracts, the outer pair rather shorter than the inner ones. Griffith, No. 4992, from Afghanistan, in Herb. Kew, with 2 ducts on the upper side of the broader leaves, may belong here, which would extend the geographical area of this species.

12. *P. Merkusii*, Jungh. & De Vriese, seems to be closely allied to the last and probably belongs here, or ought perhaps to be considered rather a two-leaved *Indica*. In the poor specimens at my disposal I could not discover any ducts; the leaves are longer and more slender, the strengthening cells similarly disposed. The involucrum consists of 12 bracts, the outer pair not half as long as the inner ones.

13. *P. Gerardiana*, Wallich. Anther crests semi-orbicular, laciniate-dentate, seeds nearly 1 inch long.

14. *P. Halepensis*, Mill. Cones with longer or shorter peduncles, lateral and often low down on the axis, generally single, with flat or sometimes somewhat tumid scales.

15. *P. Pyrenaica*, Lapeyr., fide Parlatore, *P. Brutia*, Ten., and with other synonyms, not to be confounded with that other *P. Pyrenaica* which is a form of *P. Laricio*. This species is so closely allied to the last that it is often considered a variety of it. But the leaves are stouter, the more numerous ducts are surrounded by strengthening cells, which are very scarce in the leaves of the other; in both, these cells are found near the vessels; the male flowers are twice as large; the outer pair of involucral bracts is almost equal to the inner ones; the cones are nearly sessile and thicker, generally several together, and often lateral and terminal on the same tree (see p. 171); the densely clustered cones in Tenore's typical specimen in the botanic garden of Naples are the result of disease.

16. *P. leiophylla*, Schiede & Deppe, has often 6 and even 7 leaves; the ducts are very small and often wanting; the strengthening cells, usually well developed in bundles under the epidermis, are, as well as the ducts, absent in Gregg's No. 821 from Zamora; the sheaths are usually deciduous, but scarcely so in Hartweg's No. 441.

17. *P. filifolia*, Lindl. In a specimen cultivated in Kew gardens the ducts are sometimes internal.

18. *P. Montezumæ*, Lamb., is, if I understand it correctly, a most variable species, the largest suit of different forms of which is preserved in the Berlin herbarium; some forms have longer, others shorter leaves, or stouter or more slender ones, 3, 4 or 5 in a bundle; cones long cylindrical or oval or conical; the scales in the typical form are depressed and regularly rhomboidal, in other forms they become strongly umbonate. It is quite diffi-

cult, therefore, to properly circumscribe the species; for the present I feel obliged to unite with it even *P. Hartwegii* and a number of others already included by Parlatore. Only a closer study on the Mexican mountains will decide whether or not several well characterized species may be hidden among them. All those that I could examine have numerous and strong bundles of strengthening cells under the epidermis and also near the vessels, but none around the ducts.

19. *P. Torreyana*, Parry, has the same structure of the leaves. The name was published in the Botany of the Mexican Boundary, 1859, and is therefore older than *P lophoserma*, Lindl. of 1860.

20. *P. Arizonica*, Engelm. in Bot. Wheeler, p. 260, has also this structure and is thus distinguished from *P. ponderosa*, besides being five-leaved.

21. *P. Engelmanni*, Carrière, Conif. p. 356; *P. macrophylla*, Engelm. in Wisliz. Mem. p. 103, note 25, is a tree only known from Wislizenus' single specimen gathered in 1846 on the mountains of Cosiquiriachi, west of Chihuahua, where it is said to be abundant. The name was changed by Carrière because it clashed with Lindley's prior one; this, however, is considered by Parlatore to be a form of *Montezumæ*, but which I have not been able to examine. Our plant differs from this species by having its very stout leaves in threes and fours and very rarely in fives, in the strongly developed strengthening cells under the epidermis and also around the ducts, and in the form of the cone. Parlatore does not mention it.

22. *P. ponderosa*, Douglas, a variable and wide-spread species of Western North America, several forms of which have been described as distinct. The only one which may perhaps claim specific recognition is our var. *Jeffreyi* (*P. Jeffreyi*, Murr.), characterized by its darker more finely cleft bark, glaucous branchlets, paler foliage, and much larger cones, with rather slender sharp recurved prickles and larger seeds; but it seems that intermediate forms unite it with the typical one. Another form which deserves notice is var. *scopulorum*, of the Rocky Mountains, with shorter and often binate leaves and smaller cones (see Engelm. in Fl. Calif 2, p. 125).

23. *P. Canariensis*, Ch. Smith, is perhaps more nearly related to *P. Laricio* than to *ponderosa*. The articulation of the 4 involucral bracts is a curious feature which it has in common with our *P. resinosa* (see p. 168).

24. *P. Chihuahuana*, Engelm., first described from the mountains of Chihuahua, but now repeatedly found in Arizona, is well distinguished from all its relatives by its deciduous sheaths.

25. *P. Laricio*, Poir. Strengthening cells around ducts and in bundles all around leaf; the typical form has slender leaves and is tender in cultivation. Var. *Monspeliensis* or *Pyrenaica* (not to be confounded with No. 15, as the author of that species himself and many later botanists have done) has slender leaves with scarcely any strengthening cells around the leaf, and is more hardy than the species. Var. *Austriaca* or *nigra* is perfectly hardy; it has the stoutest leaves of all the forms, with abundant strengthening cells. A specimen in Herb. Kew, Birmah, Griffith 4993, may belong here, thus extending the range of the species far into Asia.

26. *P. Thunbergii*, Parlat. This is *P. Massoniana*, Sieb. & Zucc., and of many authors and many gardens, but is easily distinguished by its stouter, shorter leaves with parenchymatous ducts. It seems peculiar to Japan, though cultivated in Australia, whence *P. Australasiaca*, Steud., an original specimen of which I have been able to examine in Herb. Cosson. Its parenchymatous ducts distinguish this species at once from any other Japanese pine and place it near *P. Laricio*.

27. *P. contorta*, Dougl., is a little out of place here and evidently belongs nearer to the next group, but it has the subterminal cones of this. Like its American allies it is destitute of strengthening cells about the ducts, which character distinguishes it at once from its Old World associates, and so do the subulate points of the female scales. The low-growing narrow-leaved coast form, which is found along the Pacific from Northern California to Alaska is the original *P. contorta*, Douglas (from the mouth of the Columbia river) and *P. Bolanderi*, Parlat. (from Mendocino, California); it is a regular seaside tree, an excellent screen against the Pacific storms and their salt spray, just as *P. Halepensis* is on the Mediterranean; its leaves are often entirely destitute of ducts. The broader-leaved mountain form is *P. Murrayana*, Murr., as Jeffrey's original specimens prove, which come from the sierras; *P. muricata*, with which Parlatore unites it, is very different and belongs to the coast region; this broad-leaved form extends to Oregon and to the Rocky Mountains. While the forms of the coast and of the Rocky Mountains have very knobby, oblique, serotinous, and persistent cones (see p. 172), those of the sierras have occasionally more regular, less tuberculated, readily opening and deciduous cones, without being otherwise distinguishable (*C. S. Sargent*). The wood of this species is white and soft, and the tree is therefore often called white pine or spruce-pine.

28. *P. Sabiniana*, Dougl. and *P. Coulteri*, Don (*macrocarpa*, *Lindl.*) cannot be confounded by those that have been able to compare both growing; both have very large cones with spurred apophyses and large edible seeds, but the cones of *Sabiniana* are shorter, thicker, dark mahogany-brown; the seeds larger, 9–12 lines long, almost cylindrical, with much shorter wings: those of *P. Coulteri* are more slender, of a paler leather color, the seeds shorter, 6–8 lines long, and their wings longer. *P. Sabiniana* makes a round-topped tree with spreading branches and looser, more slender and lighter foliage on glaucous branchlets; *P. Coulteri* is a more conical tree with rigid brown-green branches and denser, coarser and darker foliage. The seeds of *P. Sabiniana* are or have been a most important article of subsistence for the Indians.

29. *P. insignis*, Dougl., distinguished by its fresh green foliage and closely and strongly serrulate leaves. Cones generally thick and very oblique, with the scales of the outer side large and thick, and on the inner side smaller and flat; some cones are more regular, all the scales nearly equally flat. For the synonymy I refer to Flor. Calif. 2, 127, repeating here only that the original *P. tuberculata*, Don, is founded on an unusu-

ally slender cone of this, and that *P. Sinclairii*, Hook. & Arnott, is a factitious species compounded of a cone of this and a branch of *P. Montezumæ*. The old and evidently erroneously described *P. Californiana*, Lois., is probably our species, but cannot now be identified.

30. *P. tuberculata*, Gordon Pinet. ed. 1, 211, not Don, a name at first erroneously given to a species sent by Jeffrey, is to be retained as now in general use and because Don's original *tuberculata* is a mere form of *insignis*. *P. Californica*, Hartw., is the same. It is the smallest pine known as a tree, fruiting often when only 2 to 3 feet high and rarely ever exceeding 15 or 18 feet. (See Engelm. in Flor. Calif. 2, 128.)

31. *P. Tæda*, Lin., and *P. rigida*, Mill., have sometimes, besides the regular parenchymatous, smaller, accessory internal ducts, thus approaching the *Australes* group. The cones are of a pale brown color, mostly very spinous, and very rarely serotinous. It is confined to the wet or sandy lower districts along the coast from Delaware to Eastern Texas. The most inland localities may be the Stone Mountain near Atlanta, Georgia. and Camden in Arkansas.

32. *P. rigida* var. *serotina*, *P. serotina*, Michx., I cannot distinguish specifically from *rigida*; it is more apt to grow on wet places (whence the name *Pond-pine*) and has longer leaves (occasionally, on strong shoots, in fours), and the cones often do remain closed for several years, as is also sometimes found in the northern *P. rigida*. The typical subglobose form of the cones which Michaux figures in his Sylva is quite peculiar, but only found in the coast region of South Carolina, from whence Dr. Mellichamp sends them; further inland the cones are more elongated, often twice as long as in the northern *rigida* (Wm. H. Ravenel, Aiken, S. C.) Prof. Sargent observed it on the Georgia and East Florida coast, but not in West Florida or in Alabama. Felled trees or posts set in the ground sometimes make sprouts bearing primary leaves.

33. *P. patula*, Schiede & Deppe. The epidermis cells of the leaves protrude so that the surface appears minutely tuberculate.

34. *P. inops*, var. *clausa*, was discovered and named by Dr. Chapman at Apalachicola, Florida, and Prof. Sargent finds it quite common on Cedar Keys. It is distinguished from the species by decidedly narrower leaves and by its cones being often serotinous, more in one tree than in another. The leaves are ½ line wide, while in the species they are often ¾ and even nearly 1 line wide; the sheaths in both forms are at last deciduous; young branches green, in the northern form glaucous; involucrum of 10 to 11, in *inops* of 8 to 9 bracts; cones larger, mostly subsessile, recurved; in the other, mostly longer peduncled and patulous; cotyledons fewer, 4 or rarely 5, in the other 5 or 6.

35. *P. pungens*, Michx. Leaves rarely in threes and sometimes with accessory internal ducts. The cones persist sometimes 20 years or longer.

36. *P. muricata*, Don. Male flowers only ½ inch long in a spike of about 1 inch in length, similar to those of *tuberculata* and *insignis;* anheral crest strongly denticulate, in the others nearly entire. Specimens

have been collected at Tomales Point with subterminal cones, not different in any other respect. The cones of the southern specimens (from Monterey, etc.) have usually very long, ½ inch, and stout curved spurs, especially on the outer side, and fully deserve their specific name, but others from farther north (Mendocino, etc.) are more regular, with short and thin, though very sharp, prickles.

37. *P. Pinaster*, Ait. The male flowers form a large oval head; involucral bracts often only 3 or sometimes 4, all of equal length. Geographically and structurally this species is more nearly allied with *P. Canariensis*, less so with *Laricio*, but is distinguished from both by the lateral (quite rarely subterminal) female ament.

38. *P. mitis*, Michx. Wide-spread through the middle and partly the southern States, rare in New Jersey and not now found farther north; westward to Arkansas and to Missouri south of the Missouri river, where it is the only species of pine; it is found always on silicious soil; it furnishes excellent "hard pine" lumber. The outer pair of the 9–12 involucral bracts is scarcely half as long as the inner ones.

39. *P. glabra*, Walt. Similar to the last, with slender foliage, smoother bark (in young trees and on the branches the grayish bark is quite smooth) and almost unarmed cones, distinguished by Walter 100 years ago, but long overlooked, until W. H. Ravenel, about 25 years since, rediscovered it. Dr. Mellichamp finds it scattered on the coast of South Carolina, where it grows on the edge of or in swamps, and on the knolls in them, with *Magnolia*, *Fagus*, and *Nyssa;* rarely on sandy soil, and never in the so called Pine-barrens. He describes the branching of the tree as singularly characteristic, the spray usually being flattened somewhat like that of Cedrus. It probably extends through the lower parts of the southeastern and southern States, as it is again found in Mississippi (E. Hilgard). The tree (known in South Carolina as the *Spruce-Pine*) grows up to 80 feet in height; the gray bark of such old trees is flakey and is compared by some to that of the sugar-maple, by others to a smoothish white-oak bark. The leaves are usually 2½ to 3 inches long, not half as thick as they are wide, while in *P. mitis* their thickness exceeds half their width; the external involucral bracts are minute.

40. *P. Banksiana*, Lamb., published 1803 in Lambert's first edition, a year prior to Poiret's name of *P. rupestris*, which name, erroneously preferred by Parlatore, must give way to the former. Probably the only pine with erect or at least patulous cones; the small prickles of the very young cones soon disappear, so that the mature ones are unarmed. The base of the wing entirely covers the outer side of the seed and separates from it, just as it does in *Picea*, and which I have not seen in any other pine to this extent. The cones are often serotinous and persist for a long time. The seeds seem to germinate most readily, just like those of *P. Tæda*, and in moist sandy soil, in old fields and along railroads young trees spring up abundantly. It makes a moderate sized tree, but is perhaps never over 20 or 30 feet high, and 10–12 or very rarely 18 inches in diameter. Very

common in Northern Michigan and Wisconsin, it does not seem to extend farther westward than the Saskatchawan, where it is replaced by *P. contorta*.

41. *P. oocarpa*, Schiede. Most of the ducts are internal; occasionally a parenchymatous one was found in the leaves examined by me. Further investigation must show whether this species may not more properly be referred to its Mexican neighbors of the *Pseudo-Strobi* group. Strengthening cells are abundant around, under the epidermis and also near the vessels.

42. *P. australis*, Michx. Male flowers 2½–3 inches long, the longest of any pine, of rose-purple color; lowest pair of involucral bracts minute. On a very vigorous shoot I have seen the female ament lateral (see p. 170), a rare anomaly. In the germinating plantlet, the long wing remaining attached to the seed shell is raised up like a flag by the growing cotyledonous leaves.

43. *P. Elliottii*, Engelm. For a full account see below.

44. *P. Cubensis*, Griseb. Leaves in threes, only exceptionally in twos, 8–10 inches long, rarely longer, stout, about ¾ line wide, rigid, strengthening cells largely developed under the epidermis (so that their bundles sometimes extend from the epidermis to the ducts) and also near the vessels; bracts 3–3½ lines long, strongly fringed, reflexed, rather persistent; male flowers about 1½ inches long; involucral bracts 13–15, the outer pair half as long as the inner ones; anther-crests scarcely denticulate; cones 2½–3 inches long, short-peduncled, scales depressed; seeds 3½ lines long, faintly ridged; wing nearly twice as long, widest at base, tapering to an acutish point. The var. *tertrocarpa*, Wright, in Gris. Cat. Cub. 217, is a very curious form but not a variety. It seems that in this case the growth of the axis is entirely arrested after producing an ament, and does not even elongate in the following season; the maturing cone, therefore, remains erect near the top of the branch. I have seen an analogous arrest of growth in the biennially-maturing *Quercus chrysolepis*. It is found in different parts of Cuba, in the maritime districts as well as on the mountains, and is probably the same that gives the name to the Isle of Pines. A cone from the Bahama Islands, preserved in the Kew Museum under the name of *P. Tæda*, probably also belongs here.

45. *P. Wrightii*. Engelm. n. sp. Leaves in twos, very rarely in threes, slender, 5 to 8 inches long, ½ line or less wide; sheaths 4 lines long, with age a little shorter; bracts small (1½ lines long), very slightly fringed and rather deciduous; cones lateral, peduncled, recurved, oval, 1½ to 2½ inches long, scales radiately grooved, thickened on the crenulated edge, apophyses retused, umbo immersed, prickles short; seeds 2½ lines long, faintly ridged, wings (perhaps incomplete?) not much longer, widest above the base.—Mountains in Eastern Cuba, apparently mixed with the last, Chs. Wright No. 1462 in part, 3190. Distinguished from the allied *P. Cubensis* by its slender binate leaves, short, scarcely fringed deciduous bracts and smaller cones and seeds. I have not seen the male flowers. The cone-scales of both species are arranged in the $\frac{21}{34}$ order, the 8 and 13 spirals being the most prominent.

PINUS ELLIOTTII, Engelm. n. sp.

A large tree, 50–100, rarely to 110 feet high, 2–4 feet in diameter, with (7–15 lines thick) laminated, reddish-brown bark; leaves in twos and threes, in the axils of lanceolate, long-fringed, somewhat persistent bracts, 7 to 12 (mostly about 9) inches long, $\frac{3}{4}$ to nearly 1 line wide, rigid, closely serrulate, acutish; sheaths at first about $\frac{3}{4}$ inch long, later withering to one-half that length; resin ducts internal (adjacent to the sheath of the vascular bundles). Male flowers from the axils of similar, persistent bracts, cylindrical, elongated ($1\frac{1}{2}$ to 2 inches long), in a short head (not more than 1 inch long), each one surrounded by an involucre, 4 lines in length, of about 12 bracts, the exterior pair strongly keeled, half the length of the inner ones; anthers with semicircular, denticulate, rose-purple crests; pollen grains 0.037 to 0.045, on an average 0.04 lines in the longer diameter. Female aments peduncled, mostly 2 to 4, or rarely to 6 together, oval, purplish, at first erect, but soon assuming a horizontal and (a month later, and before the leaves are well developed) a recurved position, the axis meanwhile elongating and in vigorous trees not rarely forming a second tier of aments several inches above the first ones; the bracts above the aments bear the usual leaf-bundles, so that no naked space is left; carpellary scales broad, rounded, more or less abruptly cuspidate, their bracts half their length, transverse, retuse. Cones peduncled, recurved, oval to cylindrico-conical, 3 to $6\frac{1}{2}$, usually 4 to 5 inches long, $1\frac{3}{4}$ to $2\frac{1}{4}$ inches in diameter (when closed), of a rich brown color and almost glossy; bracts thickened, retuse, or emarginate; scales in $\frac{13}{21}$ order, the 5 and 8 spirals most conspicuous: larger scales 2 inches long and 7 lines wide; apophyses marked with grooves, radiating from the slightly prominent umbo, transversely divided by a sharp ridge, armed with a short stout or rarely a slender sharp prickle. Seeds triangular, $2\frac{1}{2}$ to $3\frac{1}{2}$ lines long, dark, slightly ridged, and rough on the under side; wing 4 or 5 times as long (13 to 16 lines long), somewhat oblique, obtuse, with nearly parallel sides, or usually somewhat broader below, its base covering the greater part of the outer or upper surface of the seed; cotyledons 6 to 9, usually 8.—*P. Tæda*, var. *heterophylla*, Elliott, Sketch 2, p. 636.

Common, in light sandy damp soil, among the sandhills near the seabeach and along the marshes near the mouths of rivers;

also found in damp clayey pine lands and with *P. rigida*, var. *serotina*, in pine-barren ponds, rarely exclusively covering small tracts, and only as a second growth in old fields. From South Carolina, on the sea islands near Charleston, to Georgia along the coast, and sparingly as far as 15 to 20 miles inland, but never very far from the influence of salt water, *Dr. Mellichamp;* to Georgia, *Elliott;* and Florida, *Canby, Curtiss;* forming forests on the St. John's river, where it is often called *Slush-pine*, and is not cut for timber, *Sargent;* "the most common pine in South Florida, the 'short-straw pine' of the wood-cutters, taller, more slender, and with harder wood than the 'long-straw pine,' *P. australis*, which is the principal forest tree of Eastern, Middle and Northern Florida," *Dr. A. P. Garber;* extending westward to Alabama, "a common tree along the bay of Mobile," *Mohr, Sargent.* Prof. Sargent observes that while the long-leaf pine rapidly disappears under the axe, Elliott's pine becomes more and more common, the young second growth forests in Florida almost entirely consisting of this species and of *Tæda.*

This is the earliest flowering pine of those regions, from 2 to 4 weeks in advance of any other pine, showing its rose-purple male flower-buds already in December, and in January or February, according to latitude and season, shedding its abundant pollen, which, wafted by the winds, is apt to cover roads and streets, and especially sheets and pools of water, far and wide, with its sulphur-looking powder. *P. australis*, also with rose-purple flowers, comes several weeks later, and then the others, *P. Tæda*, next *P. glabra* and *mitis*, and lastly *P. rigida* var. *serotina* with greenish-yellow flowers. Our species bears abundantly every year (at least in South Carolina), different from *P. australis*, which, like many other pines, is fruitful only every other season. The cones also mature and drop off earlier than those of the associated pines, and shed an abundance of seeds, which readily germinate about November, and develope their young stems in spring.

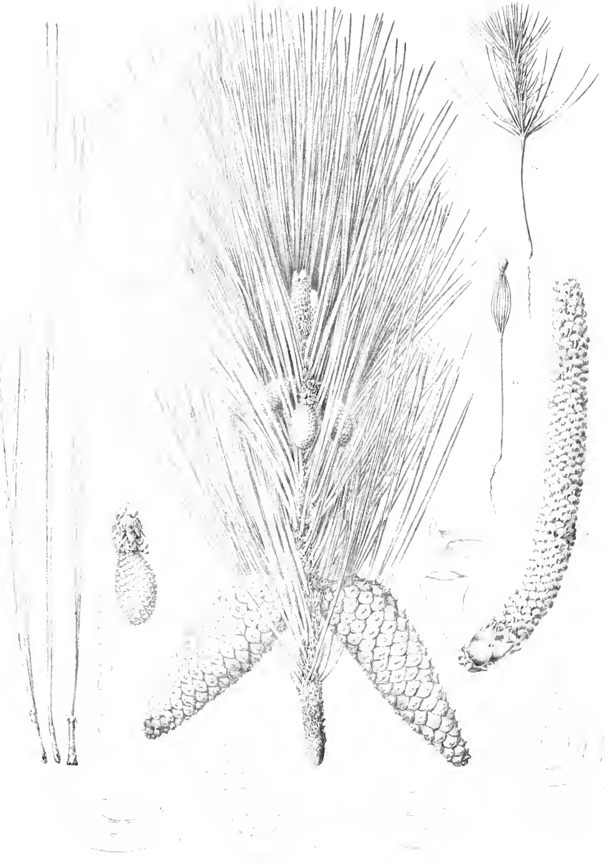
This tree Prof. Sargent considers by far the handsomest of all the southern pines, readily distinguished from those, with which it is associated, by its heavier, denser heads, darker foliage, and larger and heavier branches.

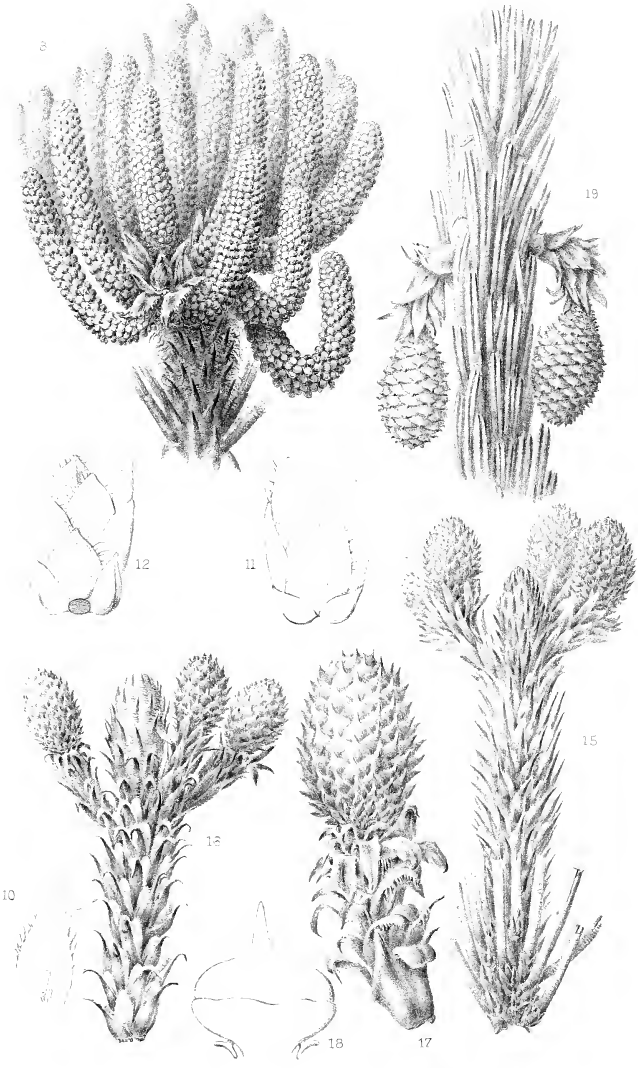
The red-brown bark is very characteristic of this species; it is regularly laminated, and the outer laminæ exfoliate in rather rigid and brittle, often very thin, plates of a purplish color when fresh, whence the local name of *Blue Pine*; the bark of *P. australis* is somewhat similar, but the plates are much larger.

The timber is excellent, heavy, very tough, and more resinous even than that of *P. australis*, which it resembles; of a striped yellowish-brown and paler resin color (the inner portion of each ring, formed earlier in the season, being paler: the outer part, of later growth, brown); fibre coarser than in *australis* and more tenacious. It grows rapidly, at least in its youth: a tree of 22 inches diameter, and about 140 years old, had in the semi-diameter 8½ inches of heartwood with 74 annual rings, and white sapwood 2½ inches thick with 60 to 70 rings; another of over 3 feet diameter, 109 feet high, and 200 years old, had a radius of 17 inches heartwood with about 140 rings, and 3 inches of sapwood of 60 rings. Thus the average rings of the heartwood were over 1⅓ lines and those of the sapwood (because of later growth) about ½ line wide. The leaves of young trees are more frequently in twos, in older ones as often in threes: those of trees from swampy soil are apt to be shorter than others; the structure in all of them is the same.

Our species is closely allied to *P. Cubensis* (see p. 185), and further study of the latter may possibly prove them to be nothing but geographical varieties. Meanwhile the constantly three-leaved foliage, the larger number of involucral bracts of the smaller male flowers, the smaller cones with smaller, shorter-winged seeds, distinguish *P. Cubensis* from our species. Of the bark, of the timber, or of the behaviour of the young cones in this species we know nothing.

P. Elliottii was imperfectly known to Elliott, and was considered by him a form of *P. Tæda*. Later botanists ignored it till Dr. J. H. Mellichamp of Bluffton, S. Car., rediscovered it about ten years ago and directed my attention to it. Without his diligent investigations, ample information, and copious specimens, this paper could not have been written. At the same time I gratefully acknowledge my obligations to many botanical friends in this country and in Europe, and especially to the directors of the

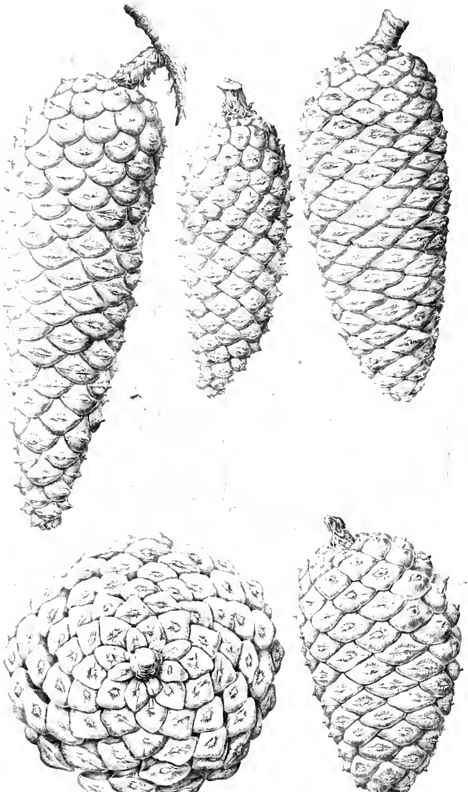




PINUS ELLIOTTII, Engelm

P Roetter from nat on stone

Print by A Meisel



botanical gardens and the curators or possessors of the great herbaria, who most liberally furnished me with the material to carry on my investigations of the Pines and of the Conifers in general. I am particularly indebted to Messrs. Bolander, Brewer, Parry and Lemmon for their contributions of the Californian and Rocky Mountain Conifers, and to Messrs. Canby, Gilman, Ravenel and Mellichamp for those of the northern and eastern American Pines.

EXPLANATION OF FIGURES.

Pl. I. fig. 1. A branch, gathered in September, showing two mature cones, of the preceding years, flowering, and three young ones of the spring. One-half nat. size.

fig. 2. Leaves in twos and threes. Nat. size.

fig. 3. Their close serratures. Magn. 60 times.

figs. 4-7. Sections of leaves magnified 30 times, 4 and 5 of binate, 6 and 7 of ternate leaves; the ducts are seen closely appressed to the sheath which encloses the vascular bundles; these bundles are, as in most pines, double, and either separate or closely approximate and almost united; the ducts are wide or small, few or many, in these specimens, varying from 4 to 9.

Pl. II. fig. 8. Male inflorescence, capitate, with the elongated flowers in the axils of fringed bracts.

Pl. I. fig. 9. One of the flowers, magn. 3 times, exhibiting the calycoid involucrum.

Pl. II. fig. 10. A bract, and

fig. 11. The involucrum from the dorsal, and fig. 12 from the ventral side, exhibiting the lowest lateral pair of bracts and the succeeding inner and upper ones. Magn. 4 times.

Pl. I. fig. 13. Diagram of the involucrum with the supporting bract; the 2 outer scales are strongly, the 4 next ones slightly, keeled.

fig. 14 and 10 bis. Effete anther from above and the side, showing the transverse erect crest and one of the longitudinally opened cells. Magn. 10 times.

Pl. II. fig. 15. Female aments in bloom, the axis above them already elongating.

fig. 16. The same, a little more advanced.

fig. 17. An ament magnified twice.

fig. 18. A female flower (carpel scale) in the axil of the broad retuse bract — only the upper, cuspidate, half being visible, and below the bifid tips of the (rather clumsily executed) ovules—in February Magn. 10 times.

fig. 19. Female aments, six weeks or two months later, recurved.

Pl. I. fig. 20. One of these, magnified.

Pl. III. figs. 21-24. Closed cones of different sizes and shapes, showing their variability.

fig. 25. Base of an open cone with spreading scales.

figs. 26, 27, 28. Scales of a cone. Fig. 26, dorsal view, showing the bract and the apophysis; fig 27, view from above, exhibiting the impression made by the seed and the surface from which the wing had become detached; fig. 28, section of a scale with the seed (exhibiting the embryo) and wing.

fig. 29. Seeds from the lower, and fig. 30 from the upper side, with differently shaped wings; in fig. 29, the rough under surface of the seed is seen; fig. 30 shows its upper surface partly denuded of the wing-covering.

figs. 31 and 32. Albumen and embryo of different shapes. Magn. 4 times.

Pl. I. fig. 33. A germinating seed in November.
fig. 34. A seedling of the following spring, exhibiting the 8 cotyledons, the primary leaves, and upwards already some pairs of secondary leaves.

The plates were drawn on stone, from nature, by Mr. Paulus Roetter, late of St. Louis, who had made himself so favorably known, more than twenty years ago, by the beautiful Cactus plates published in the Report of the Mexican Boundary Commission, and who has since greatly added to his fame and his usefulness by his artistic work in the Zoological Institute in Cambridge.

The Acorns and their Germination.

By Dr. George Engelmann.

The structure of the acorns and the germination of the oaks seemed to be so well known, that I did not pay much further attention to it until my interest was excited by the information that the germinating live-oak developed little tubers, well known to the negro children and greedily eaten by them. The notes and the specimens obtained from my South Carolina correspondents, Messrs. H. W. Ravenel, W. St. J. Mazyck (who was the first to notice this), and Dr. J. H. Mellichamp, enabled me to examine the germinating live-oak and to compare it with other oaks in this condition. I now studied the acorns, as many mature ones as I could find in my collection, and the oak seedlings which I had, as well as other seedling trees, carefully collected whenever I could obtain them. The following are the results.

In the tip of each acorn we distinguish, imbedded between the two large fleshy cotyledons, first, the little caulicle, and then at its upper end (towards the centre of the acorn) the two stalks or petioles of these cotyledons; between these the plumule is visible, more or less developed, usually only a truncate or slightly notched or emarginate knob. These parts together are in the different species and in different sized acorns usually from one to three lines long and one-half to one line in diameter; in very small acorns sometimes smaller.

The proportion of the caulicle to the stalks appears to be constant in the same species, as I have satisfied myself by examination of numerous acorns of the same species from widely separated localities.

In all the Black-oaks which I could study the caulicle is longer than the stalks. Thus in *Quercus nigra, imbricaria*, *pumila* and *Kelloggii* I find it twice as long; in *Q. coccinea* and *tinctoria*, *rubra, ilicifolia* and *agrifolia*, it is three to four times as long. *Q. densiflora* of the section *Androgyne* is similar in this respect to the first.

A few White-oaks resemble the Black-oaks in the proportion of these parts. These are *Q. macrocarpa* and *undulata*,* and especially *Q. Robur* of Europe. In this and in the Californian *Q. chrysolepis* I find the caulicle nearly three times longer than the stalks; in both of them I also notice the plumule unusually developed.

But in the majority of White-oaks the caulicle is shorter than the stalks of the cotyledons; I have seen it in the American *Q. alba, stellata, Garryana, Douglasii, Breweri, Prinus, Mühlenbergii, prinoides, Michauxii, bicolor, dumosa, pungens*,* and in *Q. occidentalis* of southwestern Europe. It is very interesting to find that in the hybrids of *Q. macrocarpa* and *alba*, which externally resemble more the former than the latter, the proportion of the stalks and the caulicle is entirely that of the latter and not of the former. I have observed this fact in hybrids from Illinois (*Hall*) as well as from Vermont (*Pringle*).

By far the longest stalks or petioles, however, are found in *Q. virens;* in this species not only the cotyledons, as is well known, but also their stalks, are coalescent: the caulicle itself is very short, only about one-fourth or one-fifth the length of the stalks, and the place where they separate from the caulicle is indicated by the very small and imperfect plumule, completely imbedded within the connate base of the stalks.

The acorns of all oaks germinate in or on the ground, the thickened stalks and the caulicle elongate; the former become 2 to 4 or nearly as much as 6 lines long, while the cotyledons themselves remain enclosed in the cracked seedshell, and from between the bases of the stalks the plumule grows up into the

* All Colorado forms of *Q. undulata* which I have examined, those with large and deciduous leaves vars. *Gambelii, Gunnisoni, Jamesii*, as well as the small- and spiny-leaved form from the edge of the cañon of the Arkansas, which I had considered as identical with *Q. pungens*, have short stalks, while the pale and usually persistent-leaved forms from Arizona, the true *Q. pungens* of Liebmann, have the stalks longer than the caulicle. Finding the proportions of these parts to be constant and as indicating specific difference, I am now inclined to consider *Q. pungens*, including *Q. grisea* as a distinct species, provided other characters can be found to confirm this view. In a few acorns of this form I have seen the cotyledons adhering together, but in the majority they were free.

ascending axis, nourished by the food contained in the cotyledons; these become exhausted and rot away about the end of the first season, while the radicle about the same time swells up, evidently absorbing part of the matter contained in them and thus laying up a store of food for the next season.

The process in *Q. virens* is essentially the same; it differs somewhat in that the connate stalk of the cotyledons remains more slender, but elongates more, mostly to the extent of one inch or even more; the caulicle and upper part of the root swells up at once, while the developing plumule forces its way up through a slit in the base of the stalk. It seems that the danger of losing connection with the storehouse of the cotyledonous mass through the long and slender passage of the stalk, necessitates the transfer of the food-matter to a nearer and safer place of deposit. But why, it may be asked, is the connection so much longer and more slender than in other oaks? At all events it suffices, as long as it is fresh and unimpaired, to carry over in a very short time the starchy and sweet contents from the cotyledons to the tuber; and before the ascending axis is an inch high and bears as yet only a few minute bracts, the tuber is already forming and it soon reaches the size of the cotyledons themselves; it is, however, longer and more slender, of a fusiform shape, about three to four lines thick and one to two inches long, attenuated below into the long tap-root.

The whole process is similar to the germination of the cucurbitaceous *Megarrhiza* of California, so beautifully illustrated by Gray in his Structural Botany; with this difference, that the cotyledons in that plant are raised above the ground, while in ours they remain hypogæous, and that the stalk is even longer, and is, together with the cotyledons, readily separable into its two component parts. In both plants a tuber forms at once by the transfer of the food-matter from the cotyledons to the radicle; in the herbaceous *Megarrhiza* the tuber becomes a permanent organ of immense size, while in the arboreous live-oak it is finally merged in the root.

CORRECTIONS.

Page 173, l. 20, and p. 180, No. 13. A cone of *Pinus Gerardiana*, just received from the Kew Museum, shows that the wings of the seeds are as small as any, and that, curiously enough, at least in this specimen, they adhere, when the seeds drop out, to the back of the scale above the one to which they belong. The description of Lambert of the wing of the seed is therefore erroneous. The number of cotyledons is ten.

Page 187, l. 26. *Pinus Tæda* flowers immediately after *P. australis*, or almost together with it, in this spring, 1880, in South Carolina, in the first week of March.

ERRATA.

Page 82, line 10 from top, for "San Louis and St. Francisco," read *St. Louis and San Francisco.*

Page 83, line 18 from top, for "$(A_1 - A)$" read $(A_1 + A)$.

" 83, " 20 " " "change," read *increase.*

" 86, " 10 " " "$k'_t = 9.56562 + 0.000916\, t$," read $k'_t = 9.56562 + 0.000192\, t$.

" 90, bottom line, for "r' tan u," read r' tan u'.

" 93, line 10 from bottom, for "change," read *decrease.*

" 99, at the head of third column, for "t," read t'.

" 129, line 2 from bottom, for $\left\{ -1 \frac{P}{(2)^2} \right\}$ read $\left\{ 1 - \frac{P}{(2)^2} \right\}$

" 138, Station *a* at Holden, for Axis reading "86^d.05," read 80.05.

" 145, line 2 from top, for "subcarniferous," read *subcarboniferous.*

" 151, " 9 " bottom, for "9 *a*)," read 9 *d*).

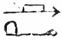
" 172, " 7 " top, for "$\frac{8}{1}$" (in part of edition), read $\frac{8}{13}$.

" 178, " 17 " " " "*heteroyhylla*," read *hcteorophylla.*

" 181, " 10 " " " "*lophoserma*," *lophosperma.*

I

a		Al	ϬN	The almighty
a		nb	NHB	the king
a		mk	ΜΗϢ ϪΝ	great,
a		ank.	ἄνακ-ς	the lord
a		krp	ϬΡΗΠΕ	of the diadem.
b		hn	ϨωΝ	The mayor
b		klkl	ϬαλοϬοιλε	committing the house.
c		kr	ογροκύςιας	The lord
c		bk	Βωκ	regent [offering]
c		bt	ογοτ	The expenses.
d		k2t	(κ)ογροτ	The queen
d		km	γάμη	consort.
e		Nbkr	NHB ογρο	The royal prince

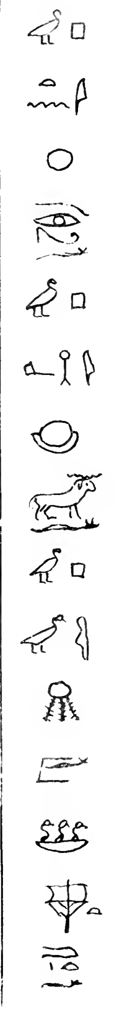
f		k z	шнрι ילד	The lad
g		ks	σιcι	Male praisers
g		bk	βακι	of the city
h		ks	σιcι	female praisers,
k		bk	βακι	of the city.
l		kpkp	ϫοπϫπ	taking
l		kz	ϣαιρι	delight.
			The Text.	
I 1		kzpa	ϣορπκοϩυφι	The chief of
2		kma	ϫομ	power,
3		mlk	מלך	the king
4		bk	βακι	of the world,
5		sp	ϣοπ	the creator
6		abt	εφουτ	of the cloak
7		bta	ουωτ	verdant

8		tb	ΤΟΥΒΟ	of the earth,
9		hpt	ϩοπτ	the builder
		kr	ϫορ	of the power
11		KL	ϭωλ כל	all
12		kb	ϩοπ חָבָה	hidden
13		n bk	ⲛ̀ ΒⲀΚΙ	in the world,
14		hpt	ϩοπτ	the builder
15		ntr	ⲛ̀ ϩτορ	of the gods,
		kc	ϭλοc	the regent
17		ke	χώϩα	of the country,
18		hpt	ϩοπτ	the builder
19		n km km tr	ⲛ̀ ϫωμ גוים ΓΗΡ	of all nations,
		nht	ⲛⲁϯ	the weaver
21		kl	ϫωιλετηη	of the lotos
II 22		hhpt	ϩⲁϩ רב	numerous

23		bk	ΒⲁΚΙ	on earth,
		htrp	ΘωρΠ	the stitcher of
		kl	Χⲁλⲁ	the constellation
26		ph	ΦΗ	of the heaven
27		sn	ϢΙΝΕ	delighting
28		ao	ⲁϣⲱ'ⲛ	every one,
29		bb	ὑφάω, weave ΒΕΒΕ	the weaver
30		ks	Κⲁιcι	of the vesture,
31		KKKT	Κⲁϩι ΚωΤ	the clothier
32		m	ⲙ̄	of
—		tk	ΤΟϬ	the plantations
34		sn	ϣινεπ]ω	delightful,
		kzf	ϩⲁⲣⲟ-ⲩ	on which
36		Kmtkm	ϪωΜ ϪωΜΤΗΡ	all nations
		tb ht	ΤⲁⲂⲈ [illegible]	originated.

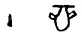
38		Kn	ΚΗΝ	the progenitor
39		n K ʔ	ν̀ Δροτιϛ	of the conqueror
		n bt. hvt	ν̀ ΒΟΤΕ ϩΠΤ	of the hideous,
III		h p t	ϩοΠΤ	the builder
42		n amn	ν̀ ΑΜΟΥΝ	of the glory,
43		Kʔ Kʔ	ουρο σρε	the illustrious lord
44		Kʔ hp	κύριος ϩΗΠΙ	manager
45		Km	ΧωΜ	of the garden
46		bK	ΒΑΚΙ	terrestrial
47		Km tz Km	Χωμ ΧωΜΤΗΡ	of all nations,
48		Kt-ef	ΧΕΤ-ΕϤ	namely of
49		ank ds	ἄνακ-ς ձυ	the governor,
50		ab	ϨΝ	together with
51		n Kʔ hp	ν κυριον ϩΗΠΙ	the manageress,
52		ank t	ΤΙ ἀνάσσα	the governess

53		Km	ϩιμεγάμη	the consort
54		kt-f	ϫετ-ϥ	who says:
55		ank	ἀνοκ	I am
56		Kr	κύριος	the lord
57		htr	ϩτορ	of the gods,
58		Kr al	κύριος [illegible]	the lord El,
59		Kr	[K]οϭρο	the lord of
60		Kmkm	ϫμϭομ	the hosts,
IV 61		bk	βωκ	the king of
// △	/// △	kb	ϫποϭτ	the nations,
63		hbt	ϩωπτ	the composer of
64		nkr kr	ουρο ⲛ̄ ϭερε	the illustrious King,
65		kp	κοπ	together with
○		krthf	ϫρωτ-εϥ	his sons;
67		hpt-f	ϩηππε'εϥ	his right eye

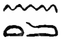


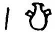
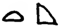
68		pthp	ⲠⲈⲦ-ⲈϤ פתח	that is
69		adn	ⲦⲒ אדן	the majesty
70		Kr	قرص	of the sun,
71		hp-hf	ϨⲎⲠⲠⲈ-Ϥ	his left eye,
72		pthp	ⲠⲈⲦ-ⲈϤ	that is
73		aha	נגה	the splendor
		mn	ⲘⲀⲚ	of the moon,
75		bk f	ⲞⲨⲞⲆⲒ-Ϥ	his face,
76		pthp	ⲠⲈⲦ-ⲈϤ	that is
77		mkh	ⲘⲞⲔϨ מכה	the vault
78		bb	ⲂⲞⲨⲂⲞⲨ	of splendor,
79		bb	ⲂⲎⲂ	the tabernacle
		mht	ⲘⲞϨ-ⲈⲚ	of luminaries
81		ttr	ⲈⲦ ⲦⲀⲢ	fixed
		m tpf	ⲘⲦⲞⲠ-Ϥ	on its bosom,

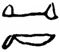
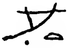
83	ahp	ⲁⲩⲱ, ἔπει	Again,
84	sp	ϣⲟⲡ	I created
85	ank	אֱנוֹשׁ	the beings
86	kt	ⲭⲉⲧ	other
87	kl	ϫⲟⲗ כֹּל	all,
88	nt as	נִדָּה ⲁϣ	the poor men,
89	k	ⲕⲉ	and
90	bt as	ⲟⲩⲟⲧ ⲁϣ	the rich men,
91	k	ⲕⲉ	and
[illegible]	krt	ϩⲏ(ⲣ)ⲧ	the souls
93	kr	ϧⲣⲏⲓ	in the
94	mr	ⲙⲏⲣⲉ	water,
95	k	ⲕⲉ	and
96	mn	ⲙⲓⲛⲉ	sorts
97	as	ⲁϣ	all of

98		k2t	KH(p)T	souls in
99		kp	KHEП	the fields,
100		k	KE	and
VI 101		hpt	ϩOOYT	the woods.
102		sp	ϣOП	I made
103		tr	TAP[illegible]	the shape
104		nas	ⲛ̀ⲁϣ	of the man,
⊗		bk	Π כ	the filament
106		tp	TⲰП	of the muscles,
107		bk	Π כ	the filament
108		gr	[illegible]ϣⲁⲣ	of the skin.
109		hpt	ϩOПT	I combined
110		kp	KAП;[illegible]P	the hair
111		nis	ⲛ̀ ⲱ́ⲛ	of the man,
112		m2tā	ⲙ̀ⲣⲏϯ	likewise

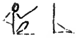
113		pb	HHBE pubes	the beard.
		sp	ϣon	I made
115		Kn	KHN	the egg
116		Kr	ϣHpι Κόgos	of the child
117		Kr	ϩpHι	within
118		as	αϣ	The man,
119		Kl	σλα	I wove
	ι 	Krt	ϩH(n)TKαϩ	the heart
121		Kr	ϧαpo	for
122		Kr mk	Xαςα	many joys,
123		bte	ογET πόθος	pleasures
124		mk		many
125		mhp	ṁ ϩHπι	in the house,
126		k	KE	and
VII 127		kr	Kpo	outside of

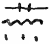
		mn	ⲙⲟⲛⲉ	the mansion.
129		ar	ⲁⲣ	I made
130		nk	ⲛⲟϭ [illegible]	the virtue
131		n as	ⲛ̀ ⲱ̀ⲡⲛ	of the man
132		m	ⲙ̀	for
133		nfr	ⲛⲟⲩϥⲣⲓ	benefitting
134		k	ⲕⲉ	even
135		snbt	ⲥⲟⲛ [illegible]	his own ones
136		kr (n) mh	ϣⲁⲓⲣⲓ (ⲛ) ⲙⲉϩ	by many joys
137		n bkr	ⲛ̀ בקר	in contemplating
138		abt	ⲁⲃⲏⲧ בית	the building
139		nk	ⲛⲟϭ [illegible]	grandious,
140		n mt	ⲛ̀ ⲙⲁⲧⲉ	in seeing
141		tt	ⲧⲁⲁⲧⲉ	the pride
142		kr (n) hp	ⲟⲩⲣⲟ (ⲛ) ϩⲏⲙⲓ	of the imperial house,

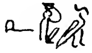
143		Krt	cur(t)ia	the residence
144		nhtr	ⲛ̀ ϩⲧⲟⲣ	of the god
145		nfr	ⲛⲟⲩϥⲣⲓ	Kind,
146		Kb	ϫⲱⲱⲃⲉ	highminded
147		Kr	ϧⲁⲣⲟ	in
148		Krt	ϩⲏ(ⲣ)ⲧ	the heart
VIII 149		Kr	ϧⲏ ϧⲛ	to
150		as	ⲱ̀ › ⲛⲁϣ	everybody,
151		Kt	ϭⲟ̄ⲧ	the image
152		n mk Kr	ⲛ ⲟⲩⲣⲟ ⲙⲏϣⲍⲍ	of the great Lord
153		nK	ⲛ̀ⲕ	for thy sake,
154		hp	ϩⲱⲃ	who made
		kt	ⲕⲁⲧ	anew
156		Kr mK	ϣⲁⲓⲣⲓ ⲙⲟϩ	a multitude of joys
157		m ar	ⲙ̀ ⲁⲣⲓ	by making

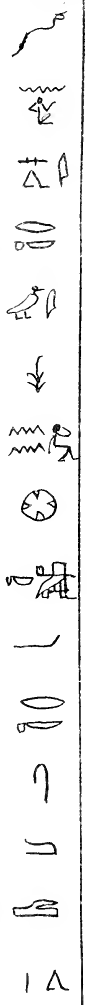
158		nk	ⲛ̄ⲛⲁⲕ	for thy behalf
159		kp	ⲔⲨⲠⲎ קֻבָּה	this chamber,
160		kl	[illegible] ϭⲟⲓⲗⲉ	the domicile
161		hpt	ϩⲟⲛⲧ ⲫϯ	of the Creator
162		bx	Ⲃⲁⲕⲓ	of the earth;
163		tk	Ⲧⲱϫ	who planted
164		mr	ⲘⲈⲒⲢⲈ	loving
165		m	ⲙ̄	in
166		krt	ϩⲏ(ⲣ)ⲧ	the heart
167		nbk	ⲛ̄ ⲂⲰⲔ	of the king
168		r	ⲛ̀	towards
169		kb	ϫⲡⲉ	the generations
170		tb tb	טוף	in the circuit
171		kp	ⲔⲀⲠ	of the earth;
172		sp	ϣⲟⲡ	I created

IX 173		hpt	εφοϒτ חפט	the cloth
174		bl	ουωιε בעל	of the gods,
175		hl	ϩΗΠΙ	the court
176		Kbkl	ככ ככ	shining
177		n as	ǹ [illegible]	for every one,
		znf	[illegible]	delighting
179		n as	ǹ a [illegible]	every one;
180		htp	ϩοτπ	I joyned
181		Ks	Καιϲ	the vesture,
182		bb	[illegible] aire	I wove
183		KKKt	Καϩι κωτ	the garment
184		m hs	ǹ ϩ ce	of Isis
185		[illegible]	εβαι חדה	house
186		Kt	[illegible]	the grain of
187		n mt	ǹ μαντιου	the mother

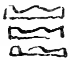
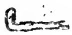
188		m kl	ⲛ̀ ϫⲟⲗ כֹּל	of all;
189		bb	weave	I wove
190		KKKt	ⲕⲁϩⲓ ⲕⲟⲧ	the garments
191		n kr bk	ⲛ̀ ϭⲉⲣⲉⲃⲁⲕⲓ	of the southern land
192		k m bk	ⲕⲁⲙ ⲃⲁⲕⲓ	and northern land,
		Kt	ϩⲓⲧⲉⲧ [illegible]	I spun
194		Kt Kn	ϩⲟⲧⲉ ⲕⲟⲩⲛ	pudendum
195		bt as	בד ϩϣ	the limb of man;
196		m a k	ⲘⲞⲔⲘⲈⲔ	I devised
197		n K	ⲚⲀⲔ	for thy sake
9		bt	בד	the limb
199		m mK	ⲙⲁϣⲓ	muliebre
200		n Km	ⲛ̀ ϫⲙϭ	for populating
201		K r	χώρα 773.	regions
202		K l	ϫⲟⲗ כֹּל	all

203		Kp	καπ	of the earth
204		Kr	ϩρⲁι אחר	conformably
		hbt	ϕ+,	to the creator
206		nk	ⲛοϭ	great
207		Kp	ⲭⲡⲉ	of the nation
208		tbtb	טדב	in the circuit
209		Kn	καπ	of the world;
210		sp	ϣοπ	I made
211		amk	עמק	the valleys,
212		Krt	חרת ϭελλοτ	the glens
213		sn	son sein	of them,
214		mk Kr	ⲙⲏϩ ιορ	the many rivers
215		m mh	ⲙ ⲙⲁϩⲓ	with the arms.
216		i	ι	my own ones.
217		hpt	ϩωπτ	Moreover

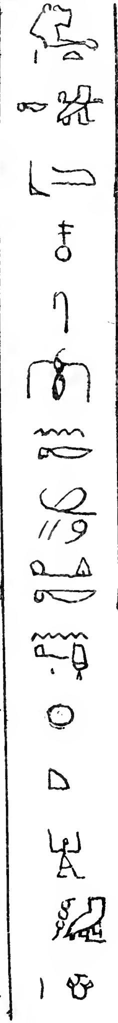
218		hb	ϩωβ	I worked
219		hpa	ϩοπι	the face,
220		hb	ϩωβ	worked
221		kr	ϧαρα	The voice
222		as	ⲁϣ	of man,
223		alal db	ⲁⲗⲟⲩ δύο	the two eyes,
224		hbt	ךד	the limbs
225		mam	חזא ⲙⲁϩⲓ	of the arms,
XII 226		bh	ⲃⲟⲩϩⲉ	the eye lids,
227		kn	ϫⲉⲛϩ	the eye lashes,
228		kr	ϧⲓⲣ	the pupil,
229		kb	σβ עב	the nose,
230		bt	ουωτ οὔατος	the ear,
231		al mak -g	אל 32-ק	thy great god;
232		kr	ⳍy	Further



233	kt	ⲔⲰⲦ	I formed
234	nas	ⲛ̀ ⲱ̀ⲥ ⲛ	for the man
235	espt	ⲉ̀ⲥⲁⲡⲧ	especially
236	klk	הלך σαλος	the walking
237	ehp	ἐπί	according
238	kr	κύριος	to the lord
239	krnn	κοίρανος	autocrat
240	bk	ⲂⲀⲔⲒ	of the world;
241	mak	ⲘⲞⲔ מכ	I devised
242	ht	ϩⲟⲧ	the socket,
243	klk	ⲔⲈⲖⲆ	the leg,
244	sb	ⲤⲎⲂⲒ	the skinbone,
245	mt	ⲁⲙⲁϩⲧⲉ	the arm,
246	tt	ⲦⲞⲦ	the hand,
247	tt	ⲦⲞⲞⲦⲈ	the feet,

248		Kp	ϭⲟⲡ כף	the palms,
XIII 249		bt	ⲟⲩⲱⲧ	the flesh
250		am	ⲡϩⲛ	of the arm,
251		bd	ⲟⲩⲱⲧ	The flesh
252		kl	ⲕⲉⲗ	of the elbow.
253		Kb	ⲕⲱⲃ	woven
254		I	I	I have
255		Km	ϫⲟⲙ	The vessel for
256		br	ⲃⲱⲣ בְּאֵר	effusing
257		mr	ⲙⲏⲣⲓ	the water;
258		hpt	ϩⲟⲡⲧ	farther
259		hpti	ϩⲟⲡⲧ-ⲓ	I combined
260		kn	ϭⲟⲛϩ	The guirdle
ꝯ		Kt-K	ϧⲉⲧ-ⲕ	of thy gut,
262		hpt	ϩⲟⲡⲧ	again

263		tp	ταγο	I stitched
264		kp	ϭοοσ	the scrotum,
265		klt	σλωτ	the testiculi
266		n	ν̀	on
267		ktk	ϩητ-κ	thy belly,
268		kp	κηβ ϩιηβ	the toes
269		tt	τατ-cι	of the foot,
270		kr	κύριος	I the lord
271		krnn	κοίρανος	autocrat
272		bk	βακι	of the world;
XIV 273		htp	ϩωπτ	again
274		trt	τωρ-†	I planted
275		kp	καπ	the hairs
276		kr	καρα	of the scull,
277		kb-i	καβ-ι	I contrived

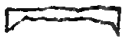


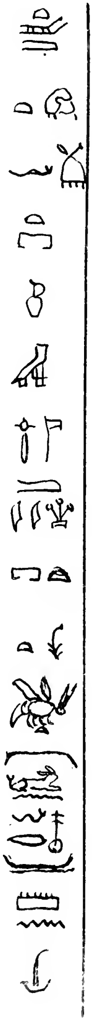
278	Kn	ϫⲟⲙ	the kittle
279	mak	מֹחַ	of the brain,
280	mbt	ⲙⲁ-ⲡⲟⲧ	the canal
	nf	ⲛⲓϥⲓ נֶפֶשׁ	of respiration,
282	8p	ϣⲟⲡ	I made
	KK	חֵךְ	the palate,
284	nK	ⲛⲁϫⲉ	The Teeth,
285	khi	ⲕⲱϩⲓ	The throat,
286	Tn-K	ⲥⲉⲛ-ⲕ	Thy voice
287	n Ka	ⲛ̀ϫⲉ	for uttering
288	Kr	ϩⲁⲣⲁ	words,
289	Kb	ϫⲱⲟⲩ	songs
290	Kr	ϣⲁⲓⲣⲓⲭⲁϫⲁ	delightful
	m Kr	ⲙ̀ ϫⲟⲣ	for comforting
292	Krd	ϩⲏ(ⲣ)ⲧ	the heart.

XV 293		ank	ⲁⲛⲟⲕ	I am
294		bb	ΒΕΒΕ neben	the procreator
295		Kr	κύριος	of the lord,
296		hms	ϣεμϣι	the servant
297		htr	ϩτωρ	of god
298		pn	כנה	that,
299		ms Klp	ΜΗϢΚΛΙΠΙ	the image
300		el Krp	ϫλΔρηπι	of the migty El,
301		Kr	(κ) ουρο	the lord
302		KmKm	ϫмϫм	of the host,
303		Kr Kr	κύριος ϭερϭ	the illustrous King
304		tktk	Τωϣ	of both hemispheres,
305		Kr	ϭρο	the conqueror
306		KrK hm	ϭορ [illegible] ϩοм	of the enemy,
307		bK	Βωκ	the prince

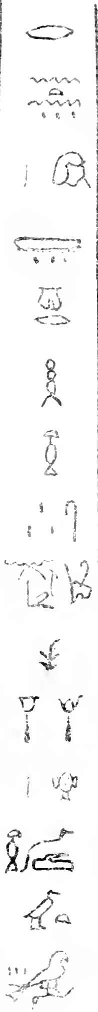
308		klk	ϩλοϫ	beneficient,
309		mlk	ΜΕλαϫ	The germ
310		kr	κύριος	of the lord
311		krnn	κοίρανος	autocrat
312		bk	ΒΑΚΙ	of the world,
XVI 313		dhm	דמה	the likeness
314		nbamn	ΝΗΒ ϯ 2Ν	of the Creator,
		kpt	ϩουιΤ	The warden
316		hnt	ϩονΤ	of the capital
317		tbk	ΒΑΚΙ	city,
318		kr	(κ)ουρο	The regent
319		ds	αϣ	of the nobility
320		nt	ΝΤΕ	and
321		bk	ΒΩΚ	of the vulgar,
322		al	אדל	The lord

	323		km	ϫⲱⲙ	of the hosts,
	324		bt	ⲟⲣⲟⲧ	the chief of
	325		al	ϧ·ⲛ̈	the planets
	326		nt	ⲛ̀ⲧ	and
	327		kz	ϧϫ̄ ϫⲁⲗ	the signs,
	328		tk	ⲧⲱϫ	the planter
	329		spt	ⲥⲟⲡⲧ	of the honoured,
	330		tk	ⲧⲱϫ	the planter
	331		bk	ⲃⲱⲕ	of the servant,
	332		kz	ϫⲟⲣ	the crusher
	333		kb	ⲥⲱⲡ	of the rebellion
	334		nb	ⲛ̀ⲃ	of
			bk	ⲃⲱⲕ	the subjects
	336		hm kzp	ϩⲁⲙ·ϫⲣⲏⲡⲓ	of the King,
XVII	337		kn	ⲕⲏⲛ	the progenitor

338		mrf	мєр-ч	of his darling,
339		n kr	(к)ογρρο	of the commander
340		km km	ϫємϫωм	of the army,
341		akt	π ⲧ̄ⲣ ἀνάκτης	whose glory of
342		kb	кβⲁ	vengeance
343		kl	ϣⲩ	to the
344		pt	ⲡⲧⲁⲧⲉ	ark
345		ph	ⲫⲏ	of heaven
346		kb-f	ϫⲱⲱⲃⲉ-ϥ	extends,
347		kn	ϫⲛⲁϩ	the suppressor
348		hm	ϩⲉⲙⲓ	of the leader
349		ms	мιϣι	attacking
350		al krp	ϫⲣⲏⲡ [illegible]	the mighty god,
351		kr	κύριος	[the Lord]
352		km km	ϫⲙⲉϫⲛⲉ	of the hosts,



353		tðm	דְּמָה	the likeness
354		Kpt	ϩοδιτ	of the head
355		Krp	κορυφή	of the capital
356		thp	ⲑⲟⲩϩⲓ	dwelling,
357		Kn	ⲕⲏⲛ	the germ
358		m	ⲙ̀	of
XVIII 359		hn	ϩⲱⲛ	the regent
360		m Kms	ⲙ̀ ⲕⲙⲥ חרם	in the dark of
361		thp	ⲑⲟⲩϩⲓ	dwelling,
362		Kr	Κυριοσ	the lord
363		mlk	מֶלֶךְ	King,
364		Kn	ⲕⲏⲛ	the progenitor
365		nfr	ⲛⲟϥⲣⲓ	good.
366		mn	מָנָה	Offer
367		m.	מְנָה	a share



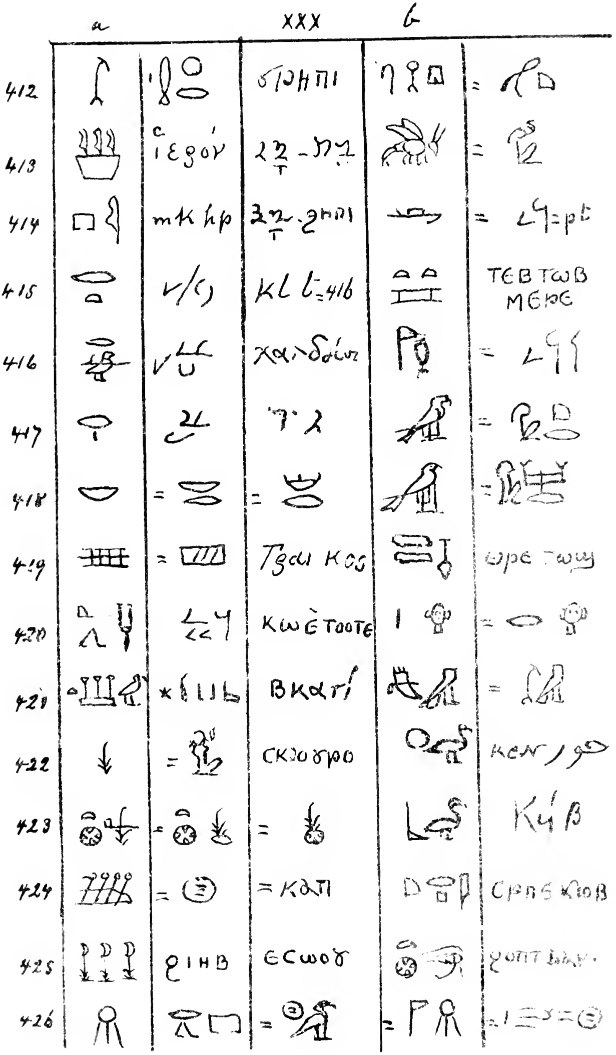
368	KI	ϩⲗⲓ כֹּל	every one
369	n-tn	ⲛ̄-ⲦⲎⲢⲞⲨ	of you.
370	kb	ⲔⲎⲂ	Weave
371	tk	ⲦⲰⲔ	robes,
◫	kl	כְּלִי ϬⲖ	raiments,
373	kt	ϩⲟⲓⲧⲉ	garments,
374	apt	ⲈⲪⲞⲨⲦ	mantles
375	sn	ⲥⲉⲛⲛⲓ – [illegible]	of flax
XIX 376	el ⁿ kzp	אל ⲛ ϣⲟⲣⲡ	the for great god,
377	Kr	κύριος	the lord
378	kmkm	ϪⲈⲘ ϪⲰⲘ	of the hosts,
379	Kr	[illegible]	and who
380	ktp	ϬⲞⲦⲠ	surpasses
381	bt	ⲞⲨⲞⲦ	the power of
382	kr	κύριος	the Cabiri.

383	hpt	ϭ' ⲟⲡⲧⲱ	the zodiacal gods,
384	hm	ϩⲏⲙⲓ	the Decani,
385	Kr	κύριος	the Lord
386	Krnn	κυίρανος	autocrat
387	bk	ⲃⲁⲕⲓ	of the world,
388	hpt	ϩⲟⲡⲧ	the creator
389	amn	ⲁⲙⲟⲩⲛ	glorious
390	n Kr	ⲛ κύριος	of the King,
391	hb	ϩⲱⲃ	the author
392	KbKb	ⲕⲱⲃⲕⲱⲃ	of the web
393	n	ⲛ̀	of the
394	Kl	[illegible]	universe;
XX 395	hb	ϩⲱⲃ	the author
396	Kmtr Km	ⲁⲙⲉⲧⲏⲣⲱⲙⲉ	of all nations,
397	tb ht	ⲧⲉⲃ ⲋⲧ'ⲡ	who acquired

398		bk	ⲂⲞϬ	glory
399		n	ⲛ̀	for
400		t̆n	ⲦⲎⲚⲞⲨ	you,
401		k3	ϬⲒⲤⲒ	who exalted
402		t̆n	ⲦⲎⲚⲞⲨ	you,
403		t̆m	ⲐⲀⲘⲒⲈ	who prepared
404		kl	[illegible] ϫⲁⲗ	a mansion
405		ke	ⲔⲈ	and
406		k [illegible]	[illegible] ϩⲣⲉ	aliment
407		n t̆n	ⲚⲦⲎⲚⲞⲨ	for you
408		mag	[illegible]	since many
409		bt	ⲀⲂⲞⲦ	years.

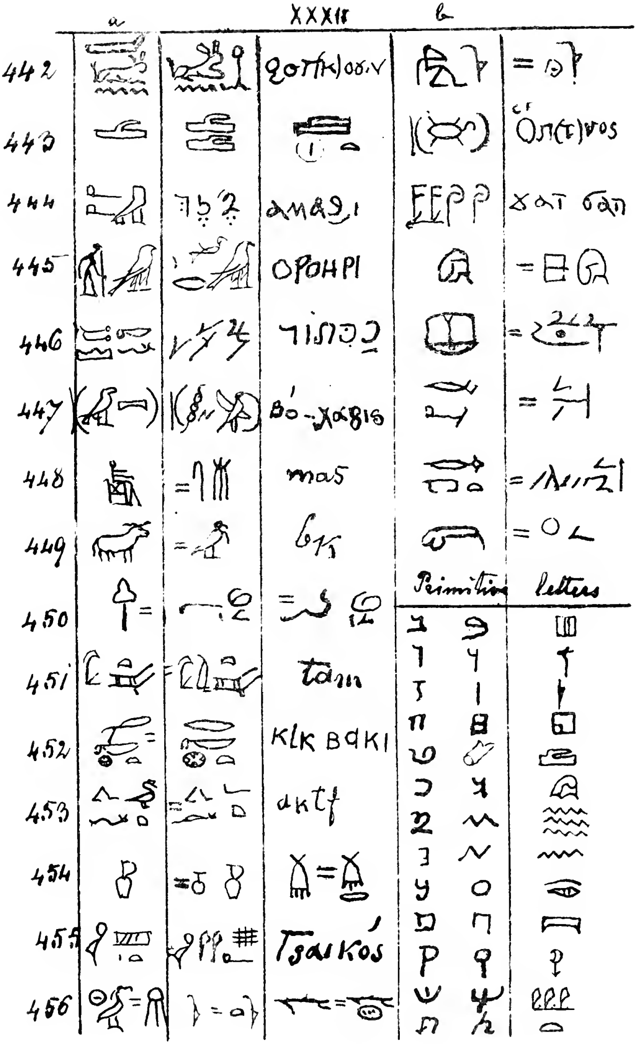
The end.

	a			b	
410			ΝΗΒ ΒΑΚΙ		
411			ⲙⲟϩⲓ		ank


a
XXX
b
412
413
ἱερόν
414
mkhp
415
TEBTωB
MEPE
416
χαλδαίων
417
418
419
420
KωὲTOOTE
421
422
423
424
425
ϩIHB
ECωOY
426

	a			b	
427					Παρτέρης
428		ϫηγ .ΠΩΤ navigare	εἰσῆλθεν		
429		ατποογι	νέον ἔτος		
430		ατϲγι Κορη —	morning star		Κερχέρης
431		πένθος	כְּאֵב		
432			ΕΜΝ=ΚΕ		Βιχέρης
433		ϩωογιτ	ἀνάβσυ		Ἀθώθης.
434			בדלת		
435					
436					ΑΡΟΗΡΙϹ
437					
438			3 2 ΜΗϢ		Mago Baki
439					
440					
441			ΑΝΑϩΗΟΥΤ		ⲛ̀ΤΕ

XXXII


a
b
442
443
cf
444
445
ΟΡΟΗΡΙ
446
447
Βο-χαβις
448
mas
449
450
451
tam
452
KIK BAKI
453
aktf
454
455
Τσαικός
456
Primitive letters

TRANSACTIONS.

The hieroglyphic Tablet of Pompeium grammatically translated and commented on

By Prof. Gust. Seyffarth, Phil. & Th. D.

INTRODUCTION.

The eruption of Vesuvius by which Pompeii and Herculaneum were destroyed, it is known, happened in the year 79 A.C., Aug. 24, two months only after Vespasian's death. Since that time the localities of both cities remained unknown, but in 1711 Pompeii and in 1738 Herculaneum came again to light, respectively 1632 and 1669 years after their interment. The Tablet under consideration was dug out in 1748 in the so-called temple of Isis, and was soon after transferred to the Museo Borbonico, where I found it in 1826 reposing and unapproachable during a period of 78 years. Nobody being permitted to copy this interesting relic of Pompeian antiquity, I was under necessity to make an especial application to the Neapolitan government itself, in consequence of which the old interdict was recalled. My exact copy will be found in my Bibliotheca Ægyptiaca MS. vol. iii. No. 2995.

The first publication of the text appeared in Brugsch's Egyptian Geography, Leipzic, 1857, Pt. lviii., which is, however, imperfect and very erroneous. For the author omitted to represent the first pictorial line, without which it is impossible to understand the contents, and, besides, he altered the genuine text in the following 33 instances, either by omitting or changing hieroglyphic figures. See the appended Plates Nos. 10, 16, 20, 24, 25, 33, 35, 37, 40, 41, 62, 66, 80, 82, 92, 105, 114, 120, 128, 155, 178, 193, 198, 205, 261, 281, 283, 291, 315, 335, 369, 372, 351.

In the same work, p. 40 & 41, Brugsch Bey experimented to explain the sense of the Pompeian stele, as follows: "It is of the time of the conquest of Egypt by Alexander the Great, but the text is (according to Champollion's hieroglyphic system) inexplicable, except Nos 69 and 71, signifying the right and the left eyes, symbolically expressed."

A complete translation of the inscription, however, issued in "Records of the Past," London, 1875, vol. iv. p. 65, made by C. W. Goodwin, M.A. He refers it "to events of the Persian period—but no king is actually mentioned in the inscription by name, nor is the particular battle described in which the person for whom the inscription was made happened to be engaged. It is, in fact, an adoration of the god Chnumis" (read Ken-nuphi), "of whom the person was the priest. This sacerdotal personage appears to have taken part in the military operations, although it is not mentioned that he had any military office. It has been arranged in paragraphs of sentences, and it is an interesting example of the inscriptions of the later period which is not much illustrated by contemporaneous monuments, although well-known from other sources. It is, however, always desirable to know the state of Egypt from its own contemporary documents, of which this is an interesting example."

The following is Goodwin's wonderful version of our Pompeian stele, based upon Champollion's hieroglyphic system, and, since it is very desirable finally to notice the difference of Champollion's theory and that of the writer, it will first be expedient to parallel the versions with each other line by line.

GOODWIN.	THE WRITER.
1. The Prince, President, keeper of the seal, Companion of the javelin, Prophet of Kar, Lord of Hebnu (Hipponomi in 16th N. E. Nome), Prophet of the gods of Sah (16th N. E. Nome), Prophet of Samtati of Ahehu,	The supreme power, the king of the earth, the creator of the verdant cloak of the world, the builder of all the powers hidden in the earth, the builder of the deities, the regent of the country, the builder of all the nations, the weaver of the numerous hotels
2. Spiritual superior of the Un, chief of the priests of Sechet in the whole land, Samtati-Taf-Necht, son of the house master,	on earth, the stitcher of the heavenly constellations delighting every one, the weaver of the vesture, the clothier of the delightful plantations on which all nations originate, the

GOODWIN.	THE WRITER.
	progenitor of the conqueror of the hideous,
3. Prophet of Amen-Ra, Shat-Tot-Samtati-Afanch (sacerdotal name), born of the lady Anchta,—said: "O! Lord of Gods, Chnum, King of the double land,	the builder of the glory of the illustrious regent, the manager of the terrestrial garden of all nations, and of the governess, his consort. He says: "I am the lord of the gods, the Lord El, the prince of the hosts,
4. Ruler of the Districts, who risest to enlighten the earth, whose right eye is the solar disk, whose left eye is the moon, whose spirit is	the king of the nations, the composer of the illustrious king as well as of his sons; his right eye, that is, the majesty of the sun; his left eye, that is, the splendor of the moon; his face, that is,
5. Shu (the dawn), from whose nostrils issues the north wind, to enliven all creatures: I am the prophet; my heart is according to thy ways; I have been faithful unto thee;	the vault of splendor, the tabernacle of luminaries fixed on its bosom. Again, I created all other beings, the poor man and the rich man, and the souls in the water, and all sorts of souls in the field, and
6. I have made no dwelling (for myself) except thy dwelling; I have not turned away from doing ...... Everyone's heart rejoiced, there was exultation in every house,	the woods; I made the shape of the man, the filament of the muscles, the filament of the skin; I combined the hair of the man, likewise the beard; I made the egg of the child within the man; I wove the heart for many joys, for many pleasures in the house and
7. on seeing what thou hast done for me to their advantage, many and many times. Thou didst give me entrance to the palace, the heart of the god (king) was pleased	outside of the mansion; I made the virtue of the man for benefitting even his own ones by many joys, in contemplating the grand building, in seeing the pride of the imperial house, the court of the kind god, highminded in the heart
8. with my words. Thou didst grant to me the oil of gladness, in that thou didst spare Egypt. Thou didst put kindness into the heart of the ruler of Asia;	to everybody, the image of the great Lord for thy sake, who made anew a multitude of joys by making in thy behalf this chamber, the domicile of the Creator of the world, who planted in the heart of the king love towards the generation in the circuit of the earth; I created

GOODWIN.	THE WRITER.
9. his counsellors did honor to me; he gave me the post of chief of the priests of Sechet in Es-Senem (Isle of Bigeh), chief of the priests of Seth-et,	the clothes of the gods, the court shining for everyone, delighting for everyone. I joined together the vesture, I wove the garments of Isis' house (of the earth), the grains of the mother of all; I wove the garments
10. of the double land, Head of the park. Thou didst defend me in the battle of the Greeks, when thou didst smife Asia,	of the southern and the northern lands; I spun the pudendum, the limb of the man; I devised the limb of matrix for thy sake for populating all countries of the earth, conformably to the great Creator of the race of nations within the circuit of the world;
11. when they killed many of my companions. He (the enemy) raised not his hand against me, (his) eyes were dull.	I made its valleys, the glens, the multitude of rivers, with my own arms. Moreover, I worked the voice of man, the two eyes, the limbs of the arms, the eyelids, the eyelashes, the pupil, the nose. the ear — I thy great God. Further, I formed for
12. Afterwards thy majesty said to me, "Go thou to Suten-Senen (Heracleopolis). Be thou diligent to traverse the regions alone	the man especially a walking according to the Lord autocrat of the world; I devised the socket of the hip-bone, the radius, the nerves, the hands, the feet, the palms, the flesh of the arm, the limb of the elbow; I have woven the vessel for
13. thyself." I embarked at Uat-Ur (Pehu of 1st N. E. Nome), I feared no difficulty, I disobeyed not thy command, I reached Suten-Senen.	effusing the water; I have, further, combined the girdle of thy gut (anus); again, I stitched the scrotum, the testiculi on thy body, the toes of the foot, I the Lord autocrat of the world.
14. Not a hair of my head was hurt. The beginning was observed in accordance with that which thou hadst commanded; in the end, thou gavest me a long space of repose.	Again, I planted the hairs of the skull, I contrived the kettle of the brain, the canal of respiration; I made the palate, the teeth, the throat, thy voice for uttering words, delightful songs for comforting the heart.
15. O! all ye priests who serve this great god, Chnum, king of the double land, Har of the horizons,	I am the emanator of the Lord, the servant of that God, the image of the mighty El, the Lord of the host,

GOODWIN.	THE WRITER.
Lord of all things, the beneficent spirit in Suten-Senen,	the illustrious King of both hemispheres, the conqueror of the enemy, the beneficent prince, the germ of the Lord autocrat ot the world,
16. Tum first in .... king of .... generations the kingdom for the ruler of lands,	the image of the Creator, warden of the capital city, the regent both of the nobility and vulgar, the lord of the hosts, the chief of the planets and the signs, the planter of the honored, the planter of the servant, the crusher of the rebellion of the subjects of the king,
17. (causing) his beloved son to be king of both lands, who comes to the heavens and beholds therein Chnum, king of both lands, Tum in his sanctuary;	the progenitor of his darling, the commander of the army, whose glory of vengeance extends to the heavenly ark, the extinguisher of the leader who attacked the mighty god, [the lord] of the host, the likeness of the head of the capital, the germ of
18. the great god who approaches the shrine of the king of Lower and Upper Egypt, Un-nefer. May your names remain upon earth (may ye be) in favor	the regent in the invisible dwelling, the Lord Regent: the Good Father. Offer a share, every one of you. Weave robes, raiments, garments, mantles of flax
19. with Chnum, king of both lands, while ye say, "May the gods, the Eyes which are in Suten-Senen, be favorable to his reverence, the devoted to his district, Samtati-Taf-Necht.	for the supreme God, the lord of the hosts, and who surpasses the power of the Planets, the zodiacal gods, the Decani, the lord autocrat of the world, the glorious procurator of the king, the creator of the web of the universe,
20. May ye yourselves be blessed. May others repeat your names for years and years."	the creator of all nations, who acquired glory for you, who exalted you, who prepared a mansion and aliment for you since many years.

THE END.

This wonderful translation of the Pompeian stele, made according to Champollion's hieroglyphic system, will finally, as I hope, open the eyes of the scientific world; it will confirm the honest confession in Bunsen's Ægypten's Stellung, etc., Hamburg, 1845, i. 320: "We declare decidedly that there is not a man alive who could read and explain [according to Champollion's

System] any whole section of the Book of the Dead, much less a historical papyrus"; it will bring to light that Champollion's theory, though sufficient for spelling a very small number of Greek and Roman proper names, was a complete failure so far as translating entire hieroglyphic texts is concerned. Indeed, since the invention of the Alphabet, I guess, no similar mass of absurdities in spite of common sense, no greater humbug and deception of the public, has been published within the compass of a few lines, except those in Kircher's translations of the Obelisks, and Brugsch's Egyptian Dictionary of four volumes.

How came this to pass? Poor Goodwin forgot that *συμβολικός* does not mean "ideologic," but syllabic. Clement of Alexandria distinguishes two classes of hieroglyphs, one being alphabetic (*διὰ τῶν πρώτων στοιχείων*), the other *συμβολική*, the synonym of *συλλαβική*, i.e. syllabic, as the context clearly evidences. This is put beyond question by a learned man, Cosmas Indicopleustes, who attests that the hieroglyphs were *γραμμάτων σύμβολα*. For it would have been nonsense to say that the hieroglyphs ideologically signify letters. An Egyptian hieroglyph could perhaps express a word, a conception, ideologically, but never the monogram of a letter ideologically; that would be a *contradictio in adjecto*. This *πρῶτον ψεῦδος* induced our Champollionist to take half of the signs on the Pompeian slab for ideologic characters, explicable to everybody's fancy, whilst the whole of the text does not contain *one ideologic hieroglyph*. The Tanis stone and the Rosetta confirm that.

Further, he did not remember that the basis of the Egyptian literature was the primitive alphabet of 25 letters, and that regularly each of the 630 hieroglyphs syllabically expressed the consonants contained in the name of the figure.

Moreover, he forgot that several hieroglyphs signified in older times other sounds than Champollion found in Greek and Roman proper names, and that the latter had wrongly determined the pronunciation of many hieroglyphic figures.

Finally, he ignored that the language subject to the Egyptian literature, commenced 2780 B.C., was not the modern Coptic, spoken from 200 to 600 A.C., but the ancient Coptic, related with the primitive language. The *ἱερὰ διάλεκτος* of the Egyptians was rather a corrupted Hebrew dialect.

All these particulars have been demonstrated in the writer's Rudimenta Hieroglyphices, Lips. 1826, pp. 12, 13, 15, 29, nota 79, 33, 39, 41; Alphabeta Genuina, Lips. 1840, p. 105; Grundsätze der Mythologie u. d. Hieroglyphensysteme; Leipziger Repertorium, 1844, Aug. 9; Jahresbericht der ersten Versammlung der Deutschen Orientalisten, 1845; Grammatica Ægypt., Gotha, 1855, pp. 2, 4, 9, 11; Beilagen, pp. 1–91, and the like.

Since, then, Mr. Goodwin followed a hieroglyphic system totally wrong, it is natural that his work is unblushing nonsense from the first to the last group, as every reader will see with his own eyes. Let us notice some of its follies.

The Pompeian Tablet was, as the title and the whole of the context demonstrates, written for the Emperor Vespasian in the time intervening between the destruction of Jerusalem in 71 A.C. and Vespasian's death on June 23, 79 A.C. The slab, besides, was inscribed in Italy and not in Egypt, owing to its material being white shell marble, which is to be found in Italy and not in Egypt. Now, our Champollionist discovered the following Italian cities: Har, Hebnu, Samtati, Ahehu, Un, Sethet, Samtati-Taf-Necht, Es-Senem, Suten-Senen, Uat-Ur, Eyes. Indeed, this is an improvement of Italian geography either 500 or 300 B.C., and the discoverer of these places will be so kind as to determine their localities. Further, the same translator discovered a number of new Italian gods, e.g., Chnum, Shu, Har, Tum, Unnofer; and he would deserve the thanks of the civilized world by evidencing what deities Chnum, Shu, Har, Tum, Unnofer have represented. However, should our able Champollionist insist upon it that the Tablet of Pompeii refers to an "Egyptian priest engaged in a battle," it would be very interesting to learn the location of the aforementioned cities as well as the proper meaning of these new Egyptian divinities. At least, the cities and the gods of Egypt are pretty well known, and yet these names have not been mentioned by any ancient or modern authority. By the way, the same city plan by which Mr. Goodwin created new cities is on the first line (unknown to him) preceded both by men and women, and this fact proves that, apart from the aforesaid eight new cities, even a city of the worshipping men and of the worshipping women, either in the time of Cambyses or Alexander the Great, either in Egypt or in Italy, must have existed.

It would be disgustful, and wasting time, to previously review all the other chimeras, wherefore we may proceed to the grammatical analysis of our 409 groups and figures on the Pompeian stele. In advance, we have to mention that the Pompeian slab, at present nearly three fingers disk, was formerly a cube, perhaps the pedestal for a statue. At least, on the edges of both sides the initial and final letters of 20 hieroglyphic lines are still to be seen. Since, moreover, the principal inscription praises the great works of God in human nature and life, we may guess that the other three sides of the cube would specify the infinite wisdom and bounty of the Creator in reference to the animal, botanical, and mineral kingdoms, of which nothing is mentioned on the main side.

Further, it is to be remembered that Vespasian, being returned from Judea and Egypt, introduced the Egyptian religion in Rome and many other Italian cities, and, no wonder, even in Pompeii.

It will be objected that Goodwin's deplorable translation of the Pompeian altar was a juvenile work, and an overhasty attempt to interpret hieroglyphic texts. But his name figures very often in "Records of the Past" since 1872, and the preface says expressly that the publication involves "the final corrections by the translators. It is hardly necessary to refer to their value as contributions to mythological, historical and philological knowledge, as this is now *universally* (?) recognized." Goodwin's version is a complete reflected image of Champollion's world-renowned system.

Furthermore, since the literature of the Egyptians commenced 3,000 years prior to the Coptic; since all languages of the world undergo alterations according to certain and common rules; since the Egyptian language, represented in all hieroglyphic texts, was, as Josephus says, a sacred dialect (*ἱερὰ διάλεκτος*), i.e. an old Coptic and Hebrew one,—it is to be borne in mind in what way older languages are transformed into later dialects. The principal and universal law is — to put in place of the hard the soft, instead of the difficult the easier, in lieu of the longer the shorter one. (See the writer's Gram. Æg. p. 3.)

PRONUNCIATION OF THE COPTIC AND HEBREW LETTERS.

ⲟⲩ before and after vowels is the consonant *w*, originated from ⲃ or ⲡ. ⲃⲱⲓⲙⲓ = ⲟⲩⲱⲓⲙⲓ. ⲛⲁⲩ = נבא. ⲧⲟⲟⲩ = תו.

ϭ is always *g*. ϭⲁⲙⲟⲩⲗ = גמל, *camelus*, *Kameel*; *columba* = ϭⲣⲟⲙⲡⲓ.

ϫ is always *k*. ϭⲁⲙⲟⲩⲗ = ϫⲁⲙⲟⲩⲗ, ϫⲁⲟⲩⲉ = קבע, ϫⲟⲡ = גמא, ϫⲟⲙ = גביע.

ⲑ is *th* and *ht*. ⲑⲉ = ⲧϩⲉ, ⲑⲉⲓ = ⲧϩⲉⲓ, ⲑⲱⲙ = חטם. ⲧϩⲓⲙⲉ = ⲑⲟⲩⲙⲉ.

ⲫ is *ph* and *hp*. ⲫϯ = ϩⲟⲡⲧ, ⲫⲉ = פאה. ⲫⲣⲱ = *hpr*, hiems.

ϫ is *kh* and *hk*. Cheops = *khp*, *Χέωψ*, ⲭⲟϩ = כאה.

ⲩ is like ⲟⲩ, the consonant *w*, before and after a vowel.

ז is *g* and ϭ. Comp. חזוהדגבא = *abcdefgh*; ⲁϭⲟⲗ = עגל = אזל. Comp. ⲧⲁϭ. Germ. Teig.

צ is *k* and ϫ; for it stands in numberless words instead of ז (*g*), כ (*k*), ק (*q*), as Gesenius (Lex. p. 778) has demonstrated. Comp. צחק = *καχάζω*.

ע the eye עין. i.e. עי with ן ephelisticum, the ancient עג. like the Lat. ocu-lus, the Ital. occhio, the Ger. Oge (Auge), Sw. oga, Russ. ako, Span. ojo, our eye (ege), expressed two different sounds viz. *o* and *g*, as Gesenius (Lex. 663) teaches. For the Septuagint interpreters expressed ע sometimes by the vowels *o*, *a*, *e*, sometimes by the consonant *g*, *γ*, e.g. in *Φάγωρ*, *Γάζα*, *Γόμοῤῥα*, etc. The Arabians and Ethiopians pronounce the same letter both as *o* and *g*. and distinguish them only by a dot. Further, in many Hebrew words we find ע expressed by a vowel, but in many others by the equivalent consonants *g*, *k*, *q* (ג. ח. כ. צ. ק). e.g. in עטר = כתר. נבע = נבג = נבך. ארעא = ארקא. עמרא = צמר. ארעא = ארין. ענא = צאן. שכך = שמע. etc. These facts demonstrate that the Hebrew letter ע represented two different sounds, *o* and *g*, and this singular phenomenon, besides being wrongly explained by Gesenius, is evidence that the author of the alphabet designed the letters, of which the names commenced with a vowel, to express sometimes the first vowel, sometimes the first consonant. Quite the same is the case with ח. which corresponds with H in the Latin alphabet, and yet was called a vowel by Hieronymus. The word *ΗΗΛΙΟΣ* and the like of the ancient Greeks clearly shows that ח. corresponding with *η*, signified sometimes the consonant *kh*, *h*, sometimes the vowel *η*. This is confirmed by the Arabians and Ethiopians expressing the same letter by two different signs, and by the Septuagint, who render ח sometimes by *e*, sometimes by *k*. The same ח with the so-called "Pattach genubhah" is even by the Rabbis taken for a vowel. Add to this that the Old Testament expresses ח sometimes by the vowels א, ה (*e*), (*i*), ע (*o*), ו (*o*), sometimes by the guttural ג, as will be seen in Gesenius's Lexicon. Hence it is probable that the generic name of *chet* (septum) was pronounced like *echet* in ⲧ-ⲁϩⲧⲟ (sepire, dare sepimentum). See Pl. xxxii. 452, *b*.

This singular ambiguity of some Hebrew letters explains the strange phenomenon that some hieroglyphs, originated from the Hebrew alphabet, signify sometimes the first vowel, sometimes the first consonant of their names. See the author's Gram. Æg. p. 9, No. 17. Hence, e.g., the handle of a knife (Gram. Æg. Pl. 48, No. 606) signifies sometimes *n*, sometimes *a*, because of its name ענד (anat), alligavit.

At present, of course, it is impossible to make out exactly in what words ע and ח signified either consonants or vowels, but in general we have to remember that they were consonants in all those words in which the LXX and the Fathers of the Church expressed them by consonants; further, where the Old Testament itself substitutes guttural consonants; furthermore, in such words in which the Arabians and Ethiopians rendered them by consonants; and, finally, in certain Hebrew words preserved in the Greek, Latin, and other languages.

THE LANGUAGE OF THE ANCIENT EGYPTIANS.

So far as the ἱερὰ διάλεκτος of the Egyptians and the gradual corruption of older languages is concerned the following rules are to be borne in mind (see p. 201):

b and *p* go over to *f*, *w*, *u*. Comp. ⲡⲁⲧ = foot; ⲃⲉⲧ = ϥⲱⲧ = ⲟⲩⲟⲧ, abstergere, delere; ⲃⲁⲓ = ϥⲁⲓ, ferre; כוכב (kokab) = ⲥⲓⲟⲩ (siv).

ג, and all the other gutturals ϫ, ϭ, ע, ϫ, ח, ϧ, כ, ⲕ, ע, ק, adopt the following softer sounds:

1. *h*, and hence nearly all Memphitic words containing ϧ (ח), have ϩ instead of ϧ in the Sahidic. Comp. moreover: caput = Haupt = ϩⲱⲟⲩⲓⲧ (howit); cavallus = havallo, חבא (chuba) = ϩⲱⲛ = ϩⲱⲃ, צבע (kapo) = ϩⲱⲃ = ϩⲟϥ, חקה (chaqh) = ϩⲱⲕⲓ, חרם (charam) = ϩⲱⲗⲙ, צלח (kelach) = γλύκυ = ϩⲟⲗϫ, חמד (chamed) = ϩⲙⲟⲧ, חמץ = (chamak), ϩⲙϫ, כהן (kohen) = ϩⲟⲛⲧ, גיר (gir) = ϩⲓⲣ, חוט (chut) = ϩⲱⲥ, גיד (gid) = ϩⲓⲧⲉ = catena, kettle; חתה (chatah) = ϩⲟⲧⲉ, גטר (gatar) = ϩⲱⲧⲣ, etc. etc.

2. *sh* and *s*, e.g. צור (kud), גדד (gadad)=ϲⲁⲧⲓ; עול (gul) = גור (gur) = χόρος = ker-l = ϣⲏⲣⲓ; מג (mag) = μέγας, mag-nus = ⲙⲏϣ; אסב (kise) = ϩⲓⲥⲉ, עבט (gebat) = ϣⲓⲃⲧ; קף (qaf) = ϣⲃⲱ, (ת)כתנ (ketonet) = ϣⲑⲏⲛ, קרא (qara) = ϣⲁⲗ, צרעא (kirga) = ϣⲁⲗⲟⲩⲕⲓ, חם (cham) = ϣⲱⲙ, חמר (chemer) = ϣⲉⲙⲏⲣ, גנד (ganad) = ϣⲛⲧ, קב (qab) = ϣⲓⲛⲉ, עור (gor) = ϣⲁⲣ, חדול (chatul) = Hathor = Athor, כבד (kabad) = ϣϥⲓⲧ, צהב (gahab) = צהב (kohab) = ϣⲱϩⲉⲃ, etc.

3. The consonant *y*, Germ *j*. e.g. in ϫⲟⲙ = ים, lebes, lacus; ϫⲣⲟϯ = ϩⲣⲟϯ = ילד (yalad); ⲕⲁϩⲓ = ⲓⲟϩⲓ, Saxon, geard = yard; Germ. gut, Gott, geben, gabe, Gans, Gurke; Low Germ. yut, Yott, yeben, yabe, Yans, Yurke, etc.

4. *u* and other vowels, e g. נוף (gup), גפף (gopap) = ⲁϥ = ap-is; צאר (kahar), the Persian חור (chur), sol. ἥλιος, ϩⲣⲁ (in ϩⲣⲁⲙⲉⲥⲥⲁ, Ramses), χύριος, herus. Herr, ⲣⲁ the sun, the lord; Κόρος, Horus, Orus; ⲕⲉⲣ-ⲛⲉ (χύριος—ϩⲏⲓ, god's house) = ⲉⲣⲡⲏ, ⲉⲣⲫⲏ.

5. *t*, e.g. צען (kaan) = Tanis; צבא (kaba) = ⲧⲃⲁ; כמון (kamon) = ⲑⲁⲙⲟⲩⲛ; צפר (kapar) = ⲑⲃⲏⲣ, saltare, חולל (cholel) = ⲧⲉⲗⲏⲗ, אצבה (ekbah) = ⲧⲏⲃ, the finger.

ה (*h*) becomes, by emollition, the spiritus lenis, e.g. ϩⲱⲃⲧ=ⲱⲛⲧ, honor = onor. Many other examples will be seen in the premises (Nos. 2 & 4).

ד (*d*) and ת (*th*) sometimes go over to *s* and *sh*. Comp. תוב (thub) = שוב (shub), חרת (charath) = χαράσσω = χαράττω; דב (dob) = ϣⲁⲩ bonus, ϲⲁⲧⲉ = ⲧⲁⲁⲧⲉ = ציין (kik), etc.

sh becomes *s*, e g. in ϣⲟⲉ = ⲥⲟϣ, ϣⲉⲛⲉ = ⲥⲉϣⲛⲉ, and in all Hebrew words containing שׂ (s). the original שׁ.

r being softened sounds *l*, as is sufficiently known from the Chinese, Hebrew and Coptic, the latter, in numberless words, putting ⲗ instead of ⲣ. e.g. ⲣⲱⲙⲓ = ⲗⲱⲙⲓ, ⲣⲓⲙⲓ = ⲗⲓⲙⲓ.

The principal difference between the ancient and modern Coptic is, however, that the latter lost many words which we find preserved in the Hebrew and kindred languages, e.g. פשתה (pishte, flax); and, secondly, that innumerable Coptic words lost one of the primitive radical letters. It is to be remembered that the Hebrew roots contain regularly three radical letters, whilst the Coptic words, originated from the Hebrew, are, at present, monosyllabic mainly. The foolish idea of Champollion that the original Coptic consisted only of monosyllabic words needs no refutation. We have to distinguish three classes of mutilated Coptic words, to-wit: first, such as lost the initial radical letter, and of this character are a great many Coptic words commencing with a vowel instead of *h*. For instance, the original name of Abydos was Habydos, because it proceeded from the root ϩⲟⲛⲧ, ϥϯ (hpt), the Creator, and was hieroglyphically expressed by the letters *hpt*. To the same class refer חטם (chatam) instead of τωм, τωτ instead of אטר (atad) firmare, ϣєτ for עצר (agad) cædere, λουλι for הלל (halal), etc.

Further, a great many Coptic words lost a middle radical letter, e.g. ϩнτ, ancient ϩнрτ, like *καρδία*, corda, Dan. hierta, Sax. herda, Eng. heart, Germ. Hertz, etc.; τλι instead of חנה. сϥ סבא (saba, bibere), Germ. saufe-n, λнοι instead of ϩλноτι = *ὕπταμαι*. In general, all Coptic words containing two consecutive vowels lost one intervening radical consonant.

Finally, a number of Coptic words were, in the course of time, deprived of their final radical, e.g. κλм instead of גמא (gama), κλн for חבא (chaba), ϫλс for ϫλτ, снτ, cauda, finis, and so on.

After these necessary preambles we proceed to the grammatical interpretation of the Pompeian stele. This being impossible without ascertaining the pronunciation of the respective hieroglyphic figures as exactly as possible, we must recur to many other, particularly bilingual inscriptions, which, for the sake of brevity, may be designated by the following abbreviations:

T. S.	signifies	the trilingual Tanis Stone.
R. S.	"	the trilingual Rosetta Stone.
H. O.	"	Hermapion's bilingual Obelisk.
T. B.	"	the so-called Todten-Buch.
G. Æ.	"	the author's Grammatica Ægyptiaca, Lips. 1855.
R. H.	"	the author's Rudimenta Hieroglyphica, Lips. 1826.
St. L. T.	"	The Transactions of the Acad. of Science of St. Louis, Mo.
Ch.	"	Champollion and the Champollionists.
G.	"	Goodwin. L. signifies Lepsius. B. signifies Brugsch Bey.

GRAMMATICAL INTERPRETATION OF THE POMPEIAN TABLET.

NOTA. — In the following disquisition we shall very often recur to the extensive Turin copy of the sacred records of the ancient Egyptians (Lepsius's Todtenbuch), and it is a meritorious work that J. Lieblein published, "Index Alphabétique de tous les mots contenues dans le Livre des Morts, Paris, 1875." It is to be regretted only that he repeated the hieroglyphs wrongly represented by Lepsius; that he again transposed the figures; that he enumerated the latter according not to their natural order, but to a preposterous system, and that he misjoined different roots in numberless instances.

A. The Pictorial Line on the appended Plates.

a. This figure is, according to the great Champollionist Brugsch Bey, the "invention of an Egyptian king who sought to terrify his subjects by horrible images of the deities, composed of human bodies and animal heads." According to Mr. Goodwin, this god represented Chnoumis — his own fabrication — for Χνουμίς, Χνομβίς, is the corrupted word ⲛⲉⲛ-ⲛⲟⲩϥⲓ, the good generator, as we shall see below. Since the ram was called ⲁⲓⲗ (G. Æ. p 59, 233), we have the word אל (El), the mighty God, the Allah of the Arabians, and hence the same name was transferred to the אלים (Elim) and אלילים (Elilim), the mighty planetary gods. See St. L. T. vol. iv. 1. Consequently, the human figure (ϩⲁⲙ) with the head of the ram signifies the Mighty (El) One, the Creator.

The added crown, נוף (nop), elatio, gives . . . . lord, and the ostrich feathers, ⲙⲁϩⲓ, ancient ⲙⲁϭⲓ, signify מג (mag), μεγ-ας, mag-nus, corruptly ⲙⲏϣ, the great (lord). This crown does not signify *n*, as Ch. imagined, but *nb*. G. Æ. p. 42, 528. Hence the R. S. lx. expresses ⲛⲏⲃ, dominium, by the same Egyptian crowns τὴν ἄνω καὶ τὴν κάτω χώραν. See Pl. xix. No. 410, *a*. The ostrich feather ⲙⲁϩⲓ, ancient ⲙⲁⲕⲓ (p. 202, 1), is not a mimetic symbol of a feather, but stands very often for ⲙⲟⲩⲕⲓ, signifying מג (mag), divinus, corruptly ⲙⲏϣ (G. Æ. p. 64). See Pl. xix. No. 410, *b*. It is therefore a gross error of L. to take the two ostrich feathers in Gensler's "Thebanische Tafeln der Sternaufgenge," Leip. 1872, for "the two feathers of the giant," instead of the two *cubiti leonis*, ⲙⲁϩⲓ, ancient ⲙⲁϭⲓ. See Pl. xix. 411, *a*. The same feather signifies (R. S. vii. xii.) god in מג-ⲁⲟⲩⲏⲧ, מג-ϩⲏⲛⲓ, temple. Pl. xxx. 413, 414.

The so-called crux ansata represents the human brain upon a table, as will be seen in T. B. Pl. xv. c. 28, and, standing for the letters *ank*, signifies first the soul, and then the synonym ἄνακ-ς, lord, king, and, with the article ⲧ, queen. See Pl. v. 52, xix. 411, *b*. For ⲱⲛϭ signifies vita, anima, as the Hebrew אנך, אנכי, אנחנו (anok, anoki, anachnu), and the corresponding Coptic ⲁⲛⲟⲕ, ⲁⲛⲟⲛ, evidence; for these words properly signify *my soul*, *our souls*.

The sceptre in the other hand of El, called ϭⲣⲉⲙ, ϭⲉⲣⲱⲃ, sceptrum, diadema, forms, together with the preceding crux ansata, the words, the lord of the sceptre, or diadem, ϭⲣⲏⲙ, the latter being alphabetically written *krp*. Pl. xxx. *a*, 412.

b. The next figure to El, ornamented with the aforesaid crown נוף, and preceding the imperial family, is obviously the governor of Pompeium, the mayor or city commander, who caused the building of a temple of El in Pompeii. This is confirmed by the vases (ϫιρ, G. Æ. p. 98, No. 511; R. S. iii. 26), involving the word ϫωιλι, גור, גור (gur), hospitium, which are offered to the God. The same oblations will be seen on obelisks for the purpose of indicating that the respective kings had built temples. See H. O. and the writer's "Theologische Schriften," Leipz. 1855.

c. Since the Uræus-snake, ⲁⲕⲱⲣⲓ, on the front of persons expresses the word (ⲕ)ⲟⲩⲣⲟ, *κύριος*, it is self-evident that the figures *c* and *e* must be royal persons. This is confirmed by the shepherd pedum, very often expressed by the letters *bk* (ⲃⲱⲕ ire, bac-ulus; Pl. xiii. 167, xiv. 335), and, being the usual insigne of Osiris, meaning the regent (ⲃⲱⲕ), as Josephus informs us. The three boundary-stones, offered by Vespasian, express the word ⲟⲩⲟⲧ, הוד (hod), valor. For the same singular representation of the boundary-stones signify the plural termination ות (wot). See Nos. 62, 135, 335. Accordingly, it was the emperor who gave the money for building the temple of El in Pompeium.

d. The female figure after Vespasian, holding a papyrus-stalk, and ornamented with the solar-corned disk, are easily understood; for the papyrus ϫωⲙ, גמא (gome), expresses the word *γαμε-τή*, the emperor's consort (G. Æ. p. 70, No. 350), and the solar disk (*kr*, G. Æ. p. 33, No. 7) with the horns (ⲧⲁⲡ, G. Æ. p. 57, No. 220) furnish the word (ⲕ)ⲟⲩⲣⲟⲧ, queen. Hence the astronomical monuments express very often the moon by the horned disk, i.e. the Hebrew מלכת השמים (melecheth hashamaim), the queen of the heavens.

e. Obviously Titus, because he bears the royal insigne on the front, together with the royal crown and the sceptre in his hand, as we have seen, signifying the royal power.

f. The figure of a boy, ϣⲏⲣⲓ, ancient *κόρος*, of course, signifies the youngest son, the baby of the emperor, namely, Domitian. Since the latter was born in the year 50 A.C., he was, when Vespasian commenced to reign in Rome in the year 71 A.C., 20 years old. Hence we conclude that the Pompeian Tablet originated in a year in which Domitian was still in his nonage, not yet 22 years old. Moreover, the anti-emperor Sabinus, suppressed in 71 A.C., and the building of the Colosseum in 72 A.C. being mentioned, it is probable that the Pompeian slab was inscribed in 73 A.C., before Domitian was out of minority, according to his image.

g, *h*, *i*, *k* represent eight male and female worshippers of El, and the adjoined figure of the terrestrial plain or semi-globe, as the ancients imagined, called ⲃⲁⲕⲓ (r. ⲃⲱⲕ, circumire), indicates that the said worshippers were inhabitants of the city, viz. Pompeii. This figure of "*Tellus*" with its four corners (east, south, west, north) is not an ideologic determinative of cities, as the poor Champollionists fancied, but always signifies the letters *bk*. G. Æ. p. 85, No. 415. The same syllabic sign recurs in Nos. 13, 23, 46, 105, 107, 162, 191, 192, 240, 272, 312, 387, and by no means indicates city names, as our geographer would have us believe.

l represents the traversing threads of a texture, the weft, Germ. Einschlag, the Coptic ⲕⲟⲡ, r. כפף (kapap), Germ. Koep-ern: wherefore it expresses *kp*. G. Æ. p. 112, No. 591. The reduplication of kp, the word ϫⲁⲡϫⲡ, capere, is formed by the subsequent breast, *k b* ⲕⲓⲃⲉ. G. Æ. p. 49, No. 153. Hence we have the word ϫⲁⲡϫⲡ, the Latin cap-ere, to take. Comp. No. 392. The following *kr* furnishes the word χάρα, gaudium, the corrupted ϣⲁⲓⲣⲓ, gaudere, as we shall see directly.

B The Text of the Pompeian Tablet.

1. The open mouth represents crying, ϩⲁⲣⲁ, קרא (qara), and hence it must express *kr* and *k*, as was already discovered in 1826 (R. H. Tab. xxxvi. ad ר No. xi.) Comp. G. Æ. p. 48, No. 143. Indeed it expresses *k*, ⲕⲉ, καὶ (R. S. v. 19; ix. 20; xiii. 38), *kr kl* in Chaldæa (T. S. l. vi. ix.), in גיר (gir, T. S. l. xxxvi.), and numberless other words of the Rosetta and Tanis stones. Poor Lepsius, imagining that the language of the ancient Egyptians was the modern Coptic, and that the open mouth, signifying *r* in Roman proper names, constantly expressed *r*, had the misfortune to spell and translate several hundred hieroglyphic words of the Tanis Stone wrongly. From the mass of his absurdities we select some specimens illustrated by their demotic orthography. See Pl. xxx. Nos. 415–17, *a*. Moreover, the word κορυφή, corruptly ϣⲟⲣⲡ, occurs very often, e.g. T. B. 26, 3, where we read Κήβ (Saturn) κορυφή, ϩⲧⲟⲣ—חת. Saturn, the first of the gods. Comp. T. B. 142, 2. G. brings out "prince."

2. The lion's claw, ϫⲁⲙⲏ, containing the letters *km*, gives ⲕⲏⲙⲉ, ϫⲱⲱⲙⲉ, קומה (qoma), corruptly ϣⲏⲙ, ϫⲟⲙ, and many similar words. G. Æ. 61, No. 249; T. B. 1*a*, 145*a*, 146*a*, etc.; St. L. T. vol. i. p. 545. Add to these the new signification discovered by Goodwin, namely, "president."

3. No name of the queen-bee being preserved in the Coptic, we must recur to the Hebrew מלך (melek), and the Greek μέλιττα, μέλισσα, the same word, owing to the usual mutation of *k* into *t* and *s*. See p. 203, No. 5. This bee, notoriously in very many places following the word κύριος, ⲕⲟⲩⲣⲟ, lord, and preceding royal names, expresses syllabically *mlk* (melek, king), for which reason it is sometimes replaced by the figure of a king. Pl. xxx. 413, *b*. Moreover, the bee signifies, in Ebers' medical papyrus, an ingredient of a dozen or more prescriptions, viz. melissa, apiastrum. Nevertheless the Champollionist Ebers, by means of a Champollionistic hocus pocus, takes the bee for "honey," because the bee makes honey. This is, no doubt, one of the greatest discoveries of the 19th century, and yet Mr. Goodwin conjures out of the bee the idea "keeper" (of the seal). Is not that wonderful?

4 is not at all a seal, but the girdle ⲙⲛⲓ, or chain, for attaching cattle. See T. B. Pl. viii. xxvi. lxx.; G. Æ. p. 103, No. 544. Accordingly we have to translate—the king of the compass (of the heavens), and not ideologically, "the seal." Comp. T. B. 125, 28, "the girdle of the earth."

5. One of the most frequently occurring images, viz. ϭⲉⲛⲛⲓ, hackled flax, by which, in numerous places, ϣⲟⲛ, Germ. schaffen, is signified. See Papyrus Stone, St. L. T. vol. i. Pl. 8, where it seventeen times expresses ϣⲟⲛ, creator. G. Æ. 102, No. 537; see following Nos. 102, 172, 210; T. S. l. xii. xxix. xxxii.; R. S. iv. 27, 31—x. 7, 14—xii. 22.

6. The well-known goblet, resting upon a table, which goblet being called ⲁⲫⲟⲧ, a. ϩⲁⲛⲟⲩ, carries the word ⲉⲫⲟⲩⲧ, a. ϩⲉⲛⲟⲩⲧ, related with habitus, Fr. habit, Germ. Habit, Lat. vestis. Since Ch. takes the flax for a particle making intransitives, and the goblet for the word "fuseau," I do not understand why Goodwin translates them "companion." See No. 173.

7. This figure, representing a weaver's shuttle (G. Æ. Pl. 47, 593), was called ⲛⲱⲧ, cursor, runner; wherefore it was to express

pt, and indeed signifies the same letters in ⲟⲩⲱⲧ, ברא (bada), unus, primus (T. S. xix. xx. xxix. and xxi.) According to the Chs., this same figure means ideologically "javelin," and gives with the preceding word, "companion of the javelin." But is not such a phrase pure nonsense? See Pl. xix. 249; xxx. 414, *b*.

8, the well-defined image of a hill or mount, ⲧⲁⲩ, ⲧⲱⲁⲩ, ⲧⲏⲉ (comp. ⲙⲁ ⲛ̀ ⲧⲏⲉ, locus montanus), the Heb. תף (tf) expresses the same letters in a great many words, e.g. ⲧⲟⲩⲃⲟ, mundus (Pl. xvi. 208, xxviii. 394, xx. 263, xiii. 165), ⲧⲁⲩⲟ (T. S. v.), ⲧⲟⲩⲃⲟ (T. S. ix.), ⲧⲉⲃ in Philopator (Pl. xxx. 415, *b*).

9. Since the axe was called ϩⲁⲧⲏⲣ (G. Æ. 87, 428) and the lettuce ⲟⲩⲟϯ, beta (G. Æ. 79, 377), we have the word ϩⲱⲛⲧ (hpt) concinnare, creare, which returns iii. 14, 18, v. 41; further, hpt (ϩⲟⲩⲓⲧ, princeps) T. S. xii. xvi. (φύλαρχος), xix. (ⲧⲁⲩⲉ, προφήτης). See Pl. xxx. No. 416, *b*. The deluded G. takes the group for "prophet," and hence the Creator was a prophet.

10. The sparrow-hawk, expressed very often by the letters *kr* (Pl. xxx. 417, *b*), signifies ϫⲟⲣ, potentia, and not, as G. imagined, Har. Besides, B. substitutes an eagle. T. B. 125, *d*; 1, 3, 4, 6; 8, 22. Pl. xxx. 418, 383, 390.

11 is not a bowl called *neb*, which word does not occur in Coptic works, but צלח (kalah), ϭⲉⲗⲓ, patina; and never expresses *nb*, but always *kl*, *kr* (כל. κύριος), Pl. vi. 56, v. 39, xx. 295, xv. 201; even אגל (agal), tenere, x. 119, and ϭⲣⲟ, xxii. 305, xxx. 418. Comp. T. B. 145, 18, with 17*b*, 4*b*, 5*b*, 60, 62, 70, etc.

12. The gutturals going over to *h*, the root of this group, are חבא (khaba), corrupted ϩⲟⲡ, tectus, obscurus. The unfortunate G., believing that all the words preceding the maps were cities, discovered the new city of "Hebnu." Comp. 105, 107.

13. See Plates, Nos. ii. *g*, *h*; iv. 23, 105, 107, 162, 240, 272, 312, 317, 381.

14. See Nos. 9, 41.

15. See Nos. 24, 57, 144, 297, 359.

16 represents a goat, and not, as B. fancied, an antelope. The former being called ϭⲓⲉ, ϭϩⲟⲉ; Germ. Ziege, we have the word ϭⲓⲟⲉ, related with ζεύς and deus. The name of the goat will be seen in Lepsius's Deukm. ii. T. 14. See Plate xxx. 412 *b*, viz., *khs*.

17. The figure of a grate, or mat, called ϫⲉⲣⲁ, ⲕⲉⲣⲁ, expresses *kr* in many words, as will be seen in G. Æ. 106, No. 556, e.g. in *Γραικός* (R. S. xiv.), and stands for the acre (*kr*) on the T. S. xxxvii. See Pl. xxx. 419*a*, in *Γραικός*. G., not knowing what to do with the goat, discovers a new city, that of "Sah." Our ligature of *kh kr* then involves *ζεὺς χώρα*, גור (gur), the god of the country, i.e. Vespasian.

18. See Nos. 9, 14.

19 contains two papyrus-stalks (ⲕⲱⲙ, גמא, gome), which, as we have seen (Pl. i. *d*), express *km* and ⲕⲏⲙⲉ in the Rosettana. Hence we have here the word ϫⲟⲙ, ϫⲉⲙϫⲟⲙ, potentia, exercitus, natio. The figure of a spade is put in the midst for the sake of symmetry, as the Egyptians did very often (T. S. xix.; T. B. 1, 8–10). The name of the spade being ⲧⲱⲣⲉ, it expresses ⲧⲏⲣ, omnis; in other places ⲑⲣⲉ, creare. See Plate xxx. 419, *b*: the creator of both zones. According to G., the nonsense "Samtati (of Ahehu)" comes out, and the very same absurdity is repeated l. ii. 36, iii. 47.

20 reads *nht*, and refers probably to the root ⲛⲁⲧ, texere, related with נוט (nut), movere. B. omitted the figures both of the track and the hill, for which reason G. took this group for ⲛ, *τοῦ*, of.

21. The sepulcral coffin, or its lid, called ⲕⲗⲏ, r. עָגַר (oker), conclusio, signifies in many places *kl* (G. Æ. p. 91, No. 463), accordingly גור (gur), ϫⲱⲓⲗⲉ, habitatio, hospitium. G. brings out "A."

22, the familiar word ϩⲁϩ, multus, with the plural termination ות (hvth). T. B. l. 1, 15, 3, 7, 14, 17, 11, 37, 49, 4, etc. G., ignoring the sign of plurality, and taking the pullet (hpt) for *u*, discovers the "country Ahehu."

23. The notable map of the earth ⲃⲁⲕⲓ expresses the same letters. Poor G. takes it for a symbolic determinative. See 13.

24 contains the letters *htrp*, because the mouth is followed by a boundary-stone, very often signifying *p*. G. Æ. p. 37, 35; T. B. i. 1, etc. Accordingly we have to spell ϩⲧⲣⲡ, ⲑⲣⲡ (p. 13), i.e. ⲑⲱⲣⲡ, stitcher. G. elicits from this passage the sense, "Spiritual superior of the Un." Is not that pure nonsense? Besides, B. omits the mouth.

25. the human skull ⲕⲁⲣⲁ, the Hebrew גֻלְגֹּלֶת (gul-gol-eth), the Latin cra-nium, signifies *kr* and *k*; never *h*, as Ch. imagined.

See G. Æ. p. 44, 115, Pl. xxx. 420, *b*; T. B. 17, 31 = 164, 1, etc. Consequently our group expresses ϫⲁⲗⲁ, אער (ager), ἄκρα, arx, the heavenly constellations, called πύργοι. B. again omitted to copy the mouth, and G. translates "of."

26, the notorious ⲡⲉ, פאה (peah), cœlum. G. improvises "the Un."

27, representing a tooth, שֵׁן (shen), furnishes the word ϣⲓⲛⲉ, quærere, referring probably to "augurium" or "delectatio." G. imagined the tooth to signify "chief."

28 is the well-known word ⲁϣ, איש (ish), the man, and also every man. G. Æ. 38, No. 43. G. takes this human figure for "man," but without any reason. See Pl. v. 49, viii. 88 & 90, ix. 104 & 111, x. 118, xi. 131, xii. 150, xiv. 177, 179, etc.

29, 30. Since the representation of a man pouring out water refers to the root ⲃⲉⲃⲉ, בבה (aba), effundere, the same group naturally expresses ⲟⲩⲏⲃ, a. ⲃⲏⲃ, sacerdos, as our bilingual inscriptions have abundantly brought to light. The word ⲃⲏⲃ, however, rather signifies illustris (ⲃⲟⲩⲃⲟⲩ), and hence the Egyptians called their priests, as we do, Reverend. In our place, however, translating this group by "priest" would make nonsense, owing to the following figure of a handkerchief (T. B. xiv. 22, 23, 24), called ⲕⲁⲓⲥⲓ, and expressing κς in Γρυκαῖς (R. S. xiv.; G. Æ. 104, No. 550), for "priests of the handkerchief" have never existed. I do not know a similar Coptic or Hebrew word signifying "to weave," and containing the same consonants; but our *weave*, Germ. web-en, Pers. caftan, Gr. ὑφάω (a-bu-bao), point us to a root *bb*, texere. Hence we translate: the weaver of the texture, the carpet of the earth. Mr. G. omits the handkerchief without mentioning his deception.

31. The first figure represents the beetle or mallet of a statuary, for which reason Cleopatra Cocce (statuaria) is, on Egyptian monuments, represented holding a similar mallet, called ⲕⲉϩⲕⲉϩ-ⲱⲛⲓ, *cædere lapides*, Heb. גגה (gaga). Hence εἰκώ, on the Door of Philæ, corresponding with the R. S., is expressed by the same mallet, signifying ⲕⲉϩⲕⲉ, imago, and the T. S. (l. xxxvii.) as well as the R. S. (l. xiv.) express στῆσαι, ⲕⲱ ⲉ ⲧⲟⲟⲧⲉ, by the same hieroglyph (Pl. xxx. 420, *a*). In our place, however, the mallet involves, by the same consonants *kk*, the word

ϩⲁϩⲓ, pl. ϩⲁϩⲏⲟⲩ, a. ϩⲁϩⲓ, vestimentum; therefore ϥⲓ ϩⲁϩⲓ signified *cylindrus textoris* — literally, the bearer of the texture. Hence ⲕⲱϩⲁϩⲏⲩ is *spoliatus vestimentis, nudatum esse.* The added letters *kt*, ⲕⲱⲧ, forms, with the preceding ⲕⲱϩⲓ. the wrapping cloth. The same group, moreover, including the same meaning, occurs farther on, Nos. 187, 190. Besides, the same word, sometimes written ⲕⲱⲧ ϩⲁϩⲓ instead of ϩⲁϩⲓ ⲕⲱⲧ, was the frequent name of the moon, because the latter, owing to her celerity, resembled a weaver, the clothier of the earth. Ch. spells our group *pakt*, which is meaningless, because the letters are very often transposed. Mr. G. brings out the city of "Seket," which is a still greater blunder.

32, 33. After *m*, ⲙ, of, we notice the figure of thrashed straw, ⲧⲟϩ, a. ⲧⲟϫ (T. B. xli.), r. תקע. דכא. דכה (daka), which signifies *t* in many proper names (G. Æ. 84, No. 407), and very often ⲧⲱϣ a. ⲧⲱϫ, *provincia, nomus*, and ⲧⲁϣ a. ⲧⲟⲕ, compingere, contexere, textura, e.g. in ⲧⲁϣ-ϣⲟⲙⲉ, a fine texture; Ger. Tuch. Hence it expresses ⲧⲟⲩ, plantation (of the earth). B. puts a line (*n*) instead of straw.

34. See 27.

35. The hamper, related with the Latin corb-is, Germ. Korb, כלוב (kelub), signifies *klp* (Pl. xxx. 421, *b*, on Minutoli's papyrus — G. Æ. 84, 405), and hence our group expresses the word ϫⲁⲣⲟ, על (gal), upon, with the suffix ϥ, "on which."

36. See 19, 47. Poor G., having forgotten the names of the papyrus and the spade, repeats the nonsensical "Samtati," and translates the preceding groups, "in the whole land," although "the whole" is not to be seen on the tablet.

37, the household name of father, generator, ⲧⲉⲃ, ⲁⲧⲟⲟⲩⲓ, with the sign of Hith-pael (הת), wherefore we have to translate: *gignunt se*, or *gignuntur*. B. changed the arm with the club, which signifies ϩⲓⲧⲉ, ferire, and ⲑ (ht) in *θαχέλοφις*, into the arm *a*, and hence poor G. creates the new city "Samtati-Taf-Nekt," without caring that no city plan — Ch's mimetic determinative of cities — follows Samtati-Taf-Nekt, and that of the word "Nekt" no trace is to be found.

38. The name of the goose was ⲉⲱⲟⲉ, related with Ger. Husche, Boh. huz, but that of the gander was ⲕⲉⲛⲉ-ⲉⲱⲟⲉ, literally the progenitor anser, the Gr. χήν; and hence the group Pl. xxx. 422, *b*,

does not signify ϣⲉ ⲣⲏ, the son of the sun, as Ch. imagined, but ⲕⲏⲛ ⲕⲟⲩⲣ, genimen Domini. The Chs., in numerous instances, took the gander for *s* instead of *k* and *kn*. Besides, ϣⲉ is the totally corrupted ϣⲏⲣⲓ, and ⲣⲏ the corrupted ⲕⲟⲩⲣⲟ, κύρι-ος. Simple G., having forgotten that the Egyptians distinguished the sexes of animals by different names (G. Æ. p. 9, No. 16), misunderstood a great many similar hieroglyphs. Our gander signifies ⲕⲏⲛ, progenitor, and not son. Hence Saturn (Κήβ, ἤτοι χρόνος) was expressed by the gander (*k*) and a foot (*b*). See Pl. xxx. 423, *b*.

39, the bowl, signifying *kr* (Nos. 11, 44, 56, 87, etc.), gives the word ϫⲣⲟ, עור (kor), victor.

40. Since the vat, בת (beth), of which the Coptic name has perhaps been preserved in ⲕⲟⲩ-ϥⲁⲧ, i.e. ⲕⲱⲃ-ⲛⲁⲧ, vas textoris, we obtain the word ⲃⲟⲧⲉ, abominabilis, with the plural termination. For the appended kernels, signifying meal or kernels of grain, ⲃⲱⲧⲉ, far (T. B. 72, 8), change very often with the three boundary-stones, the usual plural termination, ות (voth). T. B. 15, 48; 28, 5; 109, 12; 28, 5; 124, 3; 125, 32; 128, 8. Our passage obviously views Vespasian, the conqueror of the Jews. B. puts, in lieu of the vat, the figure of a court; for which reason, probably, G. brought out "house-master," notwithstanding that his "house-master No. 44 totally differs from No. 40.

41. See 9, 14, 18—the creator, and not the prophet, as G. fancied. B. transforms *bt* into *kr*.

42. ⲁⲙⲟⲩⲛ is glory, and not, as G. imagined, the god Ammon, because the figure of a man is not added.

43 is not Ra, the sun, as G. conjectured, but κύριος ϭⲣⲉ, the illustrious king (Vespasian).

44, spelled *kr hp*, is majordomo, housekeeper, steward, like No. 51. G. forgot to mark by .... that he was unable to translate this group.

45. The image of an orchard, ϫⲱⲙ, ϭⲱⲙ, which very often expresses *k*, e.g. in the name of the Decani Libra, Βιχατί (Pl. xxx. 421, *a*), r. ⲃⲓϫ, abacus libræ: and *km* in חם (kham), æstas, the corrupted ϣⲱⲙ, summer, beginning on July 20th. G. Æ. 76, 349. Nevertheless the same figure expresses *s* and *sn*, wherefore we have to refer it to ϣⲏⲛ, hortus. Hence many Egyptian cities commence with ϣⲉⲛ, hortus, followed by the name of a deity.

Even the Hebrew שין (shin) represents a garden, and not, as Gesenius believed, a tooth. This double pronunciation of the garden cannot be denied, and refutes Ch's theory. Our figure expresses likewise *s* and *sh* in Sisak, Darius, Xerxes. The group under consideration, therefore, contains *kt*, the Hebrew גד (gad), the pagan name of the goddess Earth, as Ader-Gad, Der-ceto, etc., evidence. Inconsistent G. brings out the "sacerdotal name, Shat-tat Samtati Afank." Were it not a fact, nobody would believe that a Champollionist had discovered the "sacerdotal name Shat-tat-Samtati Afank" in a passage which contains the simple words, "the manager of terrestrial gardens of all nations."

46. See Pl. ii. Nos. *g. h.* 13, iv. 23, 105, 107, 191, 192, etc.

47. See Nos. 19, 36.

48. The viper, differing from other snakes, was called ϫⲁⲧ-ϥⲉ, ϭⲁⲧ-ϥⲉ, ϭⲁⲧ-ⲃⲉ, i.e. ϫⲁⲧ-ϩⲟⲃ, ϭⲁⲧ-ϩⲃⲟ. the snake ⲕⲁⲧ. the corrupted ⲥⲓⲧ, expresed *kt* in many words (G. Æ. p. 73, No. 328), and hence we have the word ϫⲉⲧ-ⲉϥ. dictus; namely, like גא (ge).

49 The crux ansata, as we have seen (Pl. i. *a*), signifies *ank*, and hence ἄναχ-ς, regent. This is confirmed by the joined ⲁϣ = איש (ish), man, by which the word ⲁϣ ⲁⲛⲁⲕ, the man of the reign. In the Hebrew איש (ish) always precedes the main substantive, e.g. in Icharist, whilst the Egyptians put it after the main substantive. T. B. 94, 3, 144, 13, 145, 79. See farther on Nos. 88, 90.

50, the pupil of the eye, ⲁⲗⲗⲟⲩ, related with אלו. ארו. ארי (are), ecce, which, as every Egyptologist knows, expresses *a* and *ar* (G. Æ. 46, 130), and here אל (el), i.e. together with, represents a substantive, the following word commencing with *n*, the sign of the genitive. Unfortunate G. refers the eye to ⲉⲣ, facere, and translates it by "born," which, in his eyes, is the same.

51. If this group signifies "lady," the same group No. 44, of course, must likewise signify the same, and then Vespasian was a "lady." Such are the fruits of Ch's "orthodox" system.

52 is the word No. 49, already explained, but in the feminine form, because the added *t* corresponds with the Hebrew ת (ꝉ), e.g. in מלכת (melechet), regina. G. discovered the name of the said "lady," namely, "Anchta."

53, representing a wife with the papyrus-stalk (*km*), expresses, as we have seen (Pl. i. *d*), γαμετή, the emperor's consort.

54, ϫετ-εϥ, who (El) says. See No. 48. This is the first group of the Pompeian stele correctly translated by G.

55. This figure represents a man (G. Æ. p. 37, No. 40), but refers to אנוש (enosh), and not to ϩαμ, as I presumed. The Hebrew אנוש is the corrupted אנך and אנח (anoch), the Coptic αnϩ, vita, anima, and hence *anochi* and *anachnu* signify properly my soul, our souls; i.e. I, we. The same words, moreover, express also, I am, we are; and hence our human figure expresses "I am." By the way, Gesenius imagined איש (ish) to be the abbreviated אנוש (enosh), which the Egyptian literature refutes; for αϣ, the Hebrew איש (ish), is expressed by the figure 49, while אניש (enosh) belongs to the figure under consideration. The signification of the man, viz. "I am," is confirmed in T. B. 149, 43; 54, 126, 1; 33, 1, where the defunct says, "I am the killer of the serpents." Misguided G. guessed the figure of a man to signify, "O"!

56. See 11. 57. See 15.

58 is the already mentioned אל (el) together with the solar disk, signifying (π)ονρο. κύριος (43). G. brings out "Chnum," a name of his own fabrication.

59. This Egyptian sedge, followed by a bee, commonly precedes royal names, and, in certain instances, we find instead of it the figure of a king (Pl. xxx. 422, *a*). Accordingly it must signify king, lord, governor, and the like. The same figure is very often expressed by *kr*, signifying ϫερε βαnι, the warm country, southern Egypt (Pl. xxx. 423, *a*), and thus it is evident that its name must have contained the letters *kr*. Indeed, Hesych and Theophrast mention φυτόν τι γενόμενον ἐν τοῖς κατ' Αἴγυπτον ἕλεσιν, called σάρι, which was perhaps our plant, *k* very often being changed into *s* (p. 19).

60. See 47. G. elicits "the double land" instead of host. The lord of the host simply signifies *imperator*.

61. See Pl. i. *c*.

62. The nail of a finger or toe, called (?) צפר (kapar), ιεβ. ϩιεβ, ancient ϩεβ, which very often signifies *kb* (Pl. xxx. 424, *b*), and hence, in our place, the word κnεn, καn, terra, regio. B. changed the sign of plurality into duality, and G. brings out "districts."

63 is a substantive because of the following ⲛ, τοῦ, of, which, referring to ϩⲱⲃ, or ϩⲟⲛⲧ, signifies creator, artist.

64. See 43.

65 represents the warp and the woof; in one word, weaving; ⲕⲁⲛ, e.g. in ⲥⲁ-ⲛ-ⲕⲁⲛ, lintearius. Hence it is replaced by the breast (Pl. xxx. 424, *b*), and sounds *kp* in ϭⲁⲛ (R. S. ix.; T. S. iii.; G. Æ. 112, No. 588). Our *kb*, referring to ⲕⲱⲃ, קבא (qaba), גבא (gaba), conjungere, is here the particle conjunction "together with"; the corrupted ⲥⲟⲛ, simul.

66. This group, mutilated by B., expresses by the solar disk, *kr* (Nos. 64, 43); by the straw, *t* (Nos. 33, 304, 371); by the clew (ϩⲟⲛⲧ, G. Æ. 112, No. 586), the word ⲟⲩⲧ, ות (vth), plurality, or the suffix וה, יו (hf, suus, sui). Hence we have to translate ϫⲣⲟⲧ-ϥ, or ϫⲣⲟⲧ-ϩⲟⲩⲟ, r. ילד (yalat), his son, or his sons. The whole of the phrase, therefore, reads thus: I am the builder of the illustrious emperor together with his offspring. Mr. G., on the contrary, translates, "who risest to enlighten the earth," which is indeed too ingenious for human capacity. The sun occurring in this passage, says Mr. G., it must signify "enlighten," according to Ch's theory.

67, obviously the right eye with the suffix ⲉϥ, his. This is the second word of this inscription made out by guessing, which however, is not ideologic at all, but phonetic; for the R. S. vi. 28, T. S. ix. xii., signifies by the same image (r. ὄπτω, a. ὄπτω, the corrupted ϩⲛⲛⲉ, for ϩⲛⲧⲉ) is the word ϯⲡ, i.e. ϩⲟⲛⲧ, creator. See Pl. xxx. *b*, No. 425; G. Æ. 45, No. 125.

68. The vat, בית (beth), signifying in numberless places *pt* (G. Æ. 90, 519), gives ⲡⲉⲧ, qui, and the following young chick (G. Æ. 71, 312), called ϩⲁⲛⲟⲩⲓ, forms the Hebrew הוא (hava), *ille* and *ille est*, and, like הוה (hava), *was, erat* B., not knowing the key to the Egyptian literature, pronounces the same group *pu*, signifying "est," a new word generated by the great Champollionist.

69 is not only *dominus*, but also *majestas*, which gives, with the following solar disk, "the majesty of the sun."

70. See 58, 66, 64. 71. See 68. 72. See 68.

73, spelled *aha*, ancient *aka*, furnishes אגא (aga), splendor, which the Champollionists erroneously took for the name of the moon, ⲟϩ, ⲟⲟϩ, ⲟⲟⲩ.

74 is not an image of the moon, but of the poppy, called ⲛⲉ-ⲙⲁⲛ, the corrupted ⲓⲁⲛ-ⲙⲁⲛ, the flower of the moon; for ⲓⲁⲛ is the corrupted ⲕⲛⲛ, φυτόν, as Plutarch (Is. 37, p. 365) testifies (χενόσιρις-φυτόν Ὀσίριδος), and ⲙⲁⲛ agrees with Μήνη, מני (meni), moon, Mond, etc. Even the ancient Mexicans typified the moon by the flower *mohn* (poppy), and our figure of the same plant served to express Menes, G. Æ. p. 34, No. 14. G. takes, of course, the poppy for an image of the moon, and the solar disk for an ideologic sign of the sun.

75. It was demonstrated a long time ago that several hieroglyphic figures expressed different sounds, particularly such as represented different sexes. Hence the ram served to express *el*, the Hebrew *El* (p. 23); the sheep, probably, if called ⲃⲱϫ, Germ. Bock, furnished the letters *b* and *bk*, e.g. in the Decanus Abiccan; the sheep signified *sp*, a. *kp* (G. Æ. p. 59): for the ancient name of the sheep must have been kab or kap, because the constellation Aries, on the Theban catalogue of constellations, is expressed by *kp* (see Pl. xxx. 425, *a*). From this ancient *kb* the following word originated, כב-ש (keb-es), agnus ovis; ϩⲓⲏⲃ, a. ϩⲓⲏⲃ, ⲉⲥⲱⲟⲩ (esow), a. ⲉⲥⲱⲃ, our sheep; Germ. Schaf, etc. Accordingly this hieroglyph syllabically expresses ⲟⲩⲟϫⲓ, a. ⲃⲱϫⲓ, Germ. Backe, bucca, related with fac-ies and fac-e. G. discovered the sheep to have expressed "spirit," and it is not yet clear by what hocus pocus the Egyptians brought out the notion "spirit" from a sheep.

76. See Nos. 68 and 72. G. brings out the monster "Shu," because the feathers express *s* and the pullet *o* and *u*, according to Ch.

77. This group, containing the letters *mkh* (see Pl. i. *a*, vi. 63, vii. 72, 68), furnished the word ⲙⲟϫϩ, מוח (magak), cingere, cingulum, compass. G. spells this group *su*, and translates it "dawn," probably according to his own dictionary.

78, representing the beaming sun (T. B. 80, 2) and called ⲃⲟⲩⲃⲟⲩ, expresses the letters *bb*, e.g. in ⲩⲛⲉⲩ (hpp), ἵππος, Pegasus on astronomical monuments. It stands synonymically for כוח (kafh), splendor (Pl. xxix. 398), ⲛⲩⲣⲉⲧ, fulgor (Pl. xxx. 426, *a* and *b*), Epiphanes, etc. G. discovered this figure to signify "nostrils," which is very wonderful.

79, a ligature of the eared-snake (ϩωϥ) and a cave. ϸⲏϥ. הפף (hapop), expresses ϥⲏϥ. בבא (baba), antrum, spelunca, fovea. G., to the contrary, takes this group for "his," notwithstanding the figure of a cave. See Pl. xxx. 429, *a* and *b*.

80. This hieroglyph, shamefully altered by B., clearly denotes a bird's nest, ⲙⲁϩ, and expresses ⲙⲟϩ, lumina, alias ⲙⲁϩ. linum. G. Æ. p. 65, No. 267. T. B. 85, 9; 10, 17, 16; 54, 3; 142, 7. G. translates "issues," probably because the young birds issue forth their heads.

81. The representation of a mast, called ⲧⲁⲣ, signifies *tr* in the name of king Ταρχέρης (r. Ταρτέρης), the eighth king of the 5th Manethonian dynasty on Manetho's autograph at Turin. The figure can be referred to the Rabbinic root אדרא (adara), velum navis, but at any rate expresses *t* in Trajanus, and ⲧⲱⲣ, ⲧⲟⲣⲧⲱⲣ, infigere, in our place. Since this sail, as will be seen in T. B. 99, 33, is sometimes preceded by the letters *nfi*, preposterously referred to ⲛⲓϥⲓ, spirare, the luxuriant fancy of Ch. made out that the same sail expressed spirit, wind, and the like. Accordingly G. translates it "wind," without noticing that the added hill, ⲉⲧ, forms the participle "infixed."

82. The so careful copier of Egyptian inscriptions, Mr. Brugsch Bey, transforms the hill into a calf's head, i.e. *t* into *agel*, and G., by means of a magic agency, elicits from our group the notion "north," and with the preceding "the north wind." The hill ⲧⲟⲟⲩ a. ⲧⲟϥ, the Hebrew תן (taf), gives ⲧⲟⲩ. gremium.

83 is to be spelled *ahp*, owing to the name of the pullet ϩⲁⲛⲟⲩⲓ, and refers to ⲁⲩⲟ, a. ⲁϥⲟ. the Greek ἐπεί. See T. S., R. S., T. B., in numberless places. G. fetches out the meaning, "to, for the purpose."

84. See Nos. 5, 102, 210.

85. See Nos. 49, 52. The representation of the brain ⲁⲛϫ, expressed ἄναχ-ς as well as אנוש (enosh), the original אנח (anach) and אנך (anoch), properly soul. G. takes the flax, like Ch., for intransitive, and discovers the new definition "to enliven."

86, the notorious ϫⲉⲧ. alius, which is the third word of our text correctly translated by G.

87, כל (kol), all. See 39, 44, 51, 119, 201, 202, etc.

88, called ⲛⲟⲩⲧ, expresses very often *nt*. G. Æ. p. 100, No. 522; see Pl. xxxi. No. 427. *a*. According to G., this group with the following signifies "I am thy," instead of "the poor man, and."

89, the familiar ⲕⲉ, and. See 91, 95, 100, 126, 425, etc.

90. See 9, 14, 18, 41, 230 (οὔατος), 324 (πόθος), 49, 88, 104, etc.

91. See 89, 95, etc.

92. Since the ancient name of the heart was ϩⲏⲣⲧ, καρδία, corda, as we have seen, our figure expresses *krt* (comp. G. Æ. 212, No. 149, *c*), κῆρ, which notoriously signified the soul residing in the heart; and hence, as we have learned of ⲁⲛϩ and the Hebrew ענק (anak), lives, living beings. B. omitted the line after the heart.

The latter passages of the Pompeian stele are so wonderfully translated by G. that it is worth while to parallel both versions with each other for the instruction of the reader.

75,	His face	=	whose spirit	84,	I created	=	en-
76.	that is	=	is	85.	the men	=	liven
77.	the vault	=	Shu,	86,	all	=	creatures
78,	of the splendent	=	from whose	87,	other ones,	=	all.
				88.	the poor man	=	I am
79,	tabernacle	=	nostrils	89.	and	=	thy
80.	of luminaries	=	issues	90.	the rich man,	=	prophet;
81.	fixed	=	the wind	91,	and	=	my
82.	on its bosom.	=	of the North	92,	the souls	=	heart
83.	Again	=	to	93,	in the	=	is according
				94,	water	=	to thy ways.

So different are the fruits of the world-renowned key to the Egyptian literature "discovered by Ch." and of the author's "totally insane" theory.

93. The skull being called ⲕⲁⲣⲁ, expresses very often *kr*. G. Æ. 44, 115. G. brings out "according."

94 represents the sea, ⲙⲏⲣⲉ, mare; wherefore it frequently signifies *mare*. G. Æ. 36, 29. G. discovered that the sea signified "way."

95. See 89, 91. 96. See G. Æ. 107, No. 562.

97. The name of the man ⲁϣ, איש (ish), quivis, furnishes the words "every kind of." G., on the contrary, translates the letters *mn* by "I have been," of course in accordance with his own dictionary, unknown to me.

98. See 92.

99. The Egyptian name of the boat was ϫⲟⲟⲩⲓ, the corrupted ϫⲟⲓ, the Heb. צוה (kafa), corruptly צי (kaya), Lat. scapha, Gr. σκάφη, our skiff, Ger. Schiff, *k* being softened into *s* (p. 215, 58). Comp. צוף (kup), natare. Hence it expressed the word ⲕⲃⲁ, ἐπαμύνειν (R. S. vi. 41), and ⲛⲱⲧ, εἰσῆλθεν (Pl. xxxi. 428, *a*). In this place, therefore, it expresses the word ⲕⲏⲉⲛ, ⲕⲁⲛ, land. Of course there are two kinds of animals, one living in the water (94), the other on the land. G. regales his readers with the nonsense. "I have been faithful unto thee."

100. See 89, 91, 95.

101, the well-known extension of the arms, the fathom, measuring six feet, orgya, ϩⲛⲱⲧ, which exhibits the word ϩⲟⲟⲩⲧ, as ϩⲟⲛⲧ, sylvestris, and signifies very often ϩⲟⲛⲧ, adjunge, atque. G. Æ. 50, No. 160. G. takes, without any renson, these arms for "not," like Brugsch Bey. See 109, 262, 273. T. B. xli. passim.

102. See 5, 84.

103. The scarabæus, called, as the name κάνθαρος, ⲕⲉⲛ ⲧⲣⲉ (דור, dur), demonstrates, *dur*, related with tornare, tornando fingere, expresses *t* in Trajanus and *tr* in many instances. G. Æ. 71, 316. Hence the beetle signifies circumference or form, as the following words demonstrate. It is, moreover, a substantive owing to the following ⲛ, τοῦ, of. I do not understand at all how G. translates these groups by "I have made (for myself)." At the very least, he wilfully suppressed some hieroglyphs.

104, ⲁϣ, איש (ish). See 28, 49, 88, 90, 97. The Creator provided the man with muscles and skin.

105, misrepresented by B., is the well-known city plan ⲃⲁⲕⲓ, signifying here, פח (pach), funiculus, filament. B. brings out "dwelling," because city and dwelling are the same in the eyes of Mr. G.

106. The horns, ⲧⲁⲡ, express the syllable *tp* very often, e.g. in ⲁⲧⲟⲟⲩⲓ, beginning (T. S. xviii.), ⲁⲧⲟⲟⲩⲓ κόρη, Venus orientalis, the morning star. (Pl. xxxi. 429, 430, *a*.) See G. Æ. 57, Nos. 219, 220. G. elicits the word "except."

107 (see 105), obviously "cuticle," because פח (pach) signifies also "lamina."

108, the easily recognizable ⲕⲗⲁ-ϥⲧ, i.e. ⲕⲁⲗ ϩⲟⲟⲩⲧ, vestimentum capitis, expresses *k* in Decius and *kr* in עור (gor), corrupted ϣⲁⲣ, pellis, cutis. G. takes it for the suffix *k*, "thy," of the preceding "dwelling." According to G., the defunct priestly warrior had no dwelling in this world except that of "Chnumis." This is, as it seems to me, pure nonsense. See G. Æ. 101, 532, and farther on No. 252.

109, ϩⲟⲛⲧ, together. See 262. G. takes the extended arms again for "not."

110, the familiar representation of the human hair, ⲕⲁⲡ, קן (qaf), for which reason it signifies the word ϩⲏⲃⲓ, a. ϫⲏⲃⲓ, כאב (keeb), luctus. T. S. xxvi. xxix. See Pl. xxxi. 431, *a*. This representation of the hair is not, as Ch. imagined, a figurative symbolic sign, but, as Clement informs us, *κυριολογεῖ διὰ μίμησιν*, loquitur per imitationem; it is phonetic figuratively. Poor G. translates the hair with the preceding and following hieroglyphs, "I have not turned away from doing ....," which is mere fancy-work. Comp. 275.

111. See 104. G. takes it probably for "I."

112, very often translated *καί* on the R. S. and the T. S., refers to the root ⲣⲛϯ, probably the ancient ϩⲟⲣⲧ-ⲓ, imago, similitudo; therefore our group signifies "similiter." G. recurs to ⲉⲣ ϯ, and translates it by "from doing," which is irreconcilable with our bilingual monuments.

The following six words were inexplicable for G., and yet the "great master's system" is the only "key to the whole of the Egyptian literature," the Champollionists say.

113. These three birds (ⲃⲉⲛ) stand, on the Zodiac of Dendera, for the beaming sun (ⲃⲟⲩⲃⲟⲩ), and express the constellation Pegasus (ⲩⲛⲉⲩ, *ἵππος*). See 78; Pl. xxxi. 428, *b*. The same are, moreover, on Fl. O. on the Porta del Popolo, translated by *ἀγλαοποιήσας* [*Ἡλίου πόλιν*]. Hence it is evident that our group (ⲃⲟⲩⲃⲟⲩ) signifies "pubes," the letters *pb* being expressed in ⲃⲟⲩⲃⲟⲩ, particularly in connection with the hairs. See Pl. xxx. No. 42 *l*, *a*. *b*.

114. The door-bar, ⲥⲃⲉ, shamefully altered by the sign of plurality (ים, yim) by B., and, in very many places, substituted by the similitude of the flax (G. Æ. 87, 434), expresses the same letters *sp* and the word ϣⲟⲛ, schaff-en (84).

115 represents an egg, called ⲕⲛⲛ, genimen, and, standing very often in lieu of the gander, expresses *kn* in *υἱὸς Ἡλίου*, notoriously, and not ϣⲉ.

116 is *χόρος*, and not ϣηρι, child, as we have seen in the premises so often.

117, *kr*, ϩρηι, in. See 93, 121, 276, 228, 232.

118. See 28, 88, 90, 97, 104, 111, etc.

119. As the bowl, עלח. זלח (galach), σελ. expressed *kl* in Nos. 87, 56, 51, 44, it furnishes the word σλλ. אגל (agal), texere. G. takes the figure for "all."

120. See 92. B. omitted the line after the heart. G. translates the words 18–20, "everyone's heart," according to the English syntax, and it is remarkable that the Egyptians had already adopted our syntax.

121. See 93, 149, 228, 232, 276.

122, a ligature of the image of a rejoicing person, frequently expressed by the extended arms alone, with the ostrich feather. The former, referring to the root ϣⲁⲓⲣⲓ. a. *χαίρω*, עהר. זהר (gahar), expresses *kr* in many proper names, e.g. in *Κερχέρης*, *Βιχέρης*, *Μενχέρης*, *Νεφερχέρης*, etc. See Pl. xxxi. 430, *b*. The ostrich feather, as we have noticed (No. 77, Pl. i. *a*), expresses מג (mag), ⲙⲉϩ, *μέγας*, great. G. translates wonderfully, "everyone's heart rejoiced."

123. The foot, ⲡⲁⲧ, signifies *pt*, *bt* in numerous words (G. ÄE. 55, 206), and hence it expresses the synonyme of *χάρα*, the word ⲟⲩⲉⲧ, *πόθος*, delight. G. brings out "there was." The question, however, is in what Coptic dictionary *pa* or *pta* signifies "there was."

124. See 122. G. conjectures the ostrich feather to signify "exultation" sometimes.

125, according to Ch. a figurative symbolic sign of the house, is to be spelled ϩⲏⲓ. See 44, 51.

126, the notorious ⲛⲉ, and (see 100, 91, 95), means "every," according to G.

127. The solar disk, called "kur," as we have seen (Nos. 43, 64, 66, etc.), we obtain the word ⲕⲣⲟ, זר (gar), extra, outside. G. translates it "on seeing," which is indeed enigmatic, as Ch. taught.

128. This figure of the poppy-head, mercilessly transformed into a disk by B., signifies *mn* in the names of the moon, Menes, etc. (No. 74), and hence ⲙⲟⲛⲉ, mansio. G. translates the figure enigmatically by "on seeing."

129, the notorious pupil of the eye, ⲁⲗⲗⲟⲩⲩ, signifying the letters *ar*, as Plutarch says, "to make," also signifies "I made."

130, ⲛⲟⲩ, נוך (ṇuk), which occurs farther on (139), obviously expresses magnitudo, gloria, gloriosus. G. takes the group for "thou," which blunder is proof positive that our Chst. is totally ignorant of the Coptic; for ⲛⲁⲕ signifies *tibi*, and not *tu*. Hence the translation of the passage, "what thou hast done for me," is absurd. He ought to have translated thus: I made the glory or sublimity of that man who, etc.

131, ⲛ ⲁϣ· of the man, and not "for me." See 49, 28, 111, 118.

132. The owl, called ⲙⲟⲩⲗⲁϫ, expresses not only *mlk*, but also *ml*, *mr*; for instance, in the optative ⲙⲏⲣⲉ, the Lat. amare, velle (T. S. xiii. xxxvi. etc.), and in מלך (melek). See Pl. xxxi. 431 *b*.

133. The Hebrew נבל (nebel), nablium, signifies ⲛⲟϥⲣⲓ, bonus, ἀγαθόν. G. Æ. 95, No. 493. G. translates Nos. 132 and 133, "to their advantage"; but, alas, he omitted ⲛⲉ, intervening between "advantage" and "their." The said groups express "loving to benefit together with his family."

134, ϩⲁⲣⲁ, קרא (qara), signifies very often ⲛⲉ. T. S. v. vii. xix. xxi. xxiv. xxv. etc.; R. S. ii. 7, v. 22, ix. 20, x. 41, xiii. 55; G. Æ. 48, No. 143.

135, so often occurring in our bilingual and other inscriptions, and signifying "his," in the plural οἱ αὐτοῦ or οἱ αὐτῶν, vanished in the Coptic and Hebrew literature, but reappears in the German *sein*, *seine*, and the French *son*, which probably originated from *sunus*, *suni*, contracted into *suus*, *sui*. G. translates the same group "their," but there is no referrible object to this "their." In the following it is specified by what works Vespasian benefitted his subjects.

136. See No. 122.

137. The notorious figure of a fox, called ⲃⲁϣⲁⲣ, the Greek βασσάριον, fox, a. ⲃⲁⲕⲁⲣ, probably refers to the root בקר (biqer), observare. For *b* in the name of Busiris is expressed by the fox-head, and the name of king Bicheres is, on Manetho's Turin autograph, represented by the same figure (see Pl. xxxi. 432, *b*); even the T. S. expresses by a fox, upon a temple, πτεροφόρος, i.e. astronomical observer. The fox was an unaccountable mystery to Mr. G.

138, the well-known goblet, ⲁⲛⲟⲧ, a. ϩⲁⲛⲟⲧ, syllabically expresses ⲁⲧⲏⲧ, a. ⲁⲃⲏⲧ, בית (beth). See Pl. xxxi. 433, *a*. G. translates Nos. 136–38 by "many and many times," of which no trace is to be found in the context.

139, like 130, is the Coptic ⲛⲟϭ, magnus, sublimis. G. takes it again for "thou." The noble building of Vespasian is, no doubt, the immense Colosseum.

140 refers to the root ⲙⲧⲟ, conspectus; accordingly, also, conspicere. G. translates "thou didst give me," and he alone knows in what Coptic dictionary the letters *nmt* signify "didst give me."

141, the conspicuous feet ⲧⲟⲟⲧⲉ (walking), syllabically express ⲧⲁⲁⲧⲉ, splendor, pride. The Chs. take the same feet for ⲓ = ire (symbolically), and hence G. brings out "entrance," which is the same in his eyes. But, alas, the same feet express *tt* in Athothis. See Pl. xxxi. 433, *b*; G. Æ. 56, No. 208, *b*. Moreover our feet are a substantive because of the following ⲛ, the sign of the genitive.

142, consisting of the figures of the reed *σάρι*, a. *κάρι*, and the yard, ϩⲏⲓ, Germ. Hof, indicates the emperor's palace. A similar expression, ϩⲏⲓ, מלכת (meleketh), the queen's palace, will be found on the Flaminian Obelisk in Rome.

143. Since the heart was called ϩⲏⲣⲧ, a. ⲕⲏⲣⲧ, like *καρδία*, corda, our heart (No. 92), it expresses here residence, court — a word preserved in the Saxon, Armenian, Spanish, Portuguese, Irish, and Italian languages, apparently originated from the Roman *curtia*, corrupted *curia*. See G. Æ. 49, 149, *c*. Poor G. together with Ch. imagined the heart to signify ideologically "heart."

144. See Nos, 15, 24, 57.

145. See 133. G. Æ. 95, 493.

146 represents an open chamber קבה (kuba), Sp. alcova, our alcove, ⲕⲧⲏⲛ, camera, and hence it expresses syllabically *kp*, *kb*, e.g. in ϫⲱⲱⲃⲉ, extollere, high-minded. G. interprets the sign by "was pleased," but nobody can tell from what hieroglyphs this nonsense was derived. Probably the author cheated his readers by again clandestinely suppressing some glyphs.

147, ϧⲁⲣⲟ, in, because the open mouth (קרא, ϧⲁⲣⲁ) signified *kr*. See Pl. ii. 1. Probably this mouth with the following heart was taken by G. for "in the heart."

148. See 143.

149, the Hebrew על (gal), the corrupted ϩⲣⲁⲓ, אל (el). G. translates it "with."

150. See 97, 28. G. takes this figure for "my," because he knew not that the possessive suffix always stands after the substantive.

151, the notorious letters *kt* (See Nos. 48, 54), giving ⲥⲟⲧ, image. G. brought out "with my words" by means of his new syntax, and changing the singular into the plural.

152. The following words signify, according to G., "thou didst grant to me the oil of gladness," but I am unable to say by what artifices this beaming nonsense was elicited. The ligature of the solar disk with the ostrich feathers, so often occurring, signifies *kr*, *mk*, κύριος, מג (mag), ⲙⲏϣ, the mighty Lord, as we have seen. Pl. i. *a*, *d*; v. 43, 122, 124. G. Æ. 65, 271. This group commencing with ⲛ, the sign of a casus, I do not understand how these hieroglyphs could be taken for "didst" or "grant," and not for a substantive.

153, recurring again (No. 158), where it signifies: for thee, for thy behalf. I translate the group "for thee," as the so-called parallelismus membrorum requires. G. takes *nk* again for *thou*, in spite of the Coptic grammar.

154. The clew, as we have seen (66. G. Æ. 112, No. 586), called בד (bad), ϩⲟⲛⲧ, expresses in numberless places, as well as the pullet, the plural termination ות (foth), and after human members the word בד (bad) membrum. See Pl. xxxi. 434. Hence we have to translate, "who made," or "the maker." G. interprets, "grant to me"; of which I cannot find an iota.

155–56. Brugsch Bey has been so kind as to transform for him the human nose (גב. gab) into a head. Instead of ⲕⲱⲧ, iterum, G. brings out "oil." This ⲕⲱⲧ refers to the afore-mentioned multitude of joys caused by Vespasian. See 136. Our passage therefore reads thus, "the image of the Almighty Lord for thee, who made again a multitude of joys"; and not "thou didst grant to me the oil of gladness," which is a downright mistranslation.

157, ⲙ ⲁⲣⲉ, by making. This is the fourth group correctly translated by G., namely, "in that thou didst."

158 is again ⲛⲁⲕ, for thee, and not "thou," as G. imagined. See No. 153.

159 represents a kind of coffer, r. ⲕⲁⲛ, חבא (chaba), abscondere, and hence expressess *kp*, *kb*, e.g. in קב (qab), cabus, κάβος, the corrupted ϣⲏⲛⲉ (T. S. ix.), ⲕⲧⲏⲛ τετράγωνον (R. S. ix. 54), ⲕⲧⲏⲛ, planetary house or chamber (T. B. lx. lxi. 144 passim), and, being placed instead of the mountain (ϫⲱⲱⲃⲉ), signifies ⲕⲁⲛ, terra (T. S. v. vii. x.) See G. Æ. 118, No. 620, and Pl. xxxi. 434 *b*, xiii. 171, xvi. 209, xix. 248. G., as it seems to me, neglected this figure, or copulated it with the following group *kr*, signifying in his sense "to spare."

160, *kr*, gives גור (gur), ⲥⲟⲓⲗⲉ, hospitium, domicile, and not "to spare."

161, 162. This frequently occurring group signifies "Creator of the world"; for the complete eye, ϩⲏⲛⲛⲉ, a. ϩⲉⲛⲧⲉ, like ὄπτω, a. ὄπτω, containing the letters *hpt*, expresses ϩⲟⲛⲧ, creare, creator, the contracted ⲫϯ (ϩⲏⲧ). Hence the T. S. (ix.) calls Egypt "the country (ⲃⲁⲕⲓ) of the Creator," because Αἴγυπτος contains the words γαία, ⲕⲁϩⲓ, and ⲫϯ, ϩⲟⲛⲧ, the land of the Creator. Therefore Egypt was called Ἡφαιστία, terra Vulcani (ⲫϯ). Comp. T. S. xii. xxvii. ; R. S. vi. 40. Our poor Chst., imagining that all groups determined by the city plan signified cities, translates the same group always by "Egypt." See Nos. 105, 107 ; Pl. ii. *g*, *h*, etc.

163. The notorious leters *tak* represent the word ⲧⲁϫ, ⲧⲱϫ, plantare, and not, as G. imagined, "thou didst put."

164 does not signify ⲙⲁⲧⲉ, beneplacitum, kindness, as G. fancied, but ⲙⲉⲣⲉ, amare, amor ; for the hatchet or pickaxe, called ⲙⲁϩⲣⲟ, stands very often for *mr* (Pl xxxi. 435), and expresses ἀγαπᾶν (Philæ-door, R. S. vii. 28). The added figures of a hill and boundary-stone express the letters *tw*, i.e. ⲧⲟⲩⲓⲟ — properly, dividere in duas partes — and hence the ancient word δύο, duo, our two, G. zwei, Russ. tva, Slav. dwa, Sanscr. dui, Pers. du, etc. Hence these letters were very often put after syllabic hieroglyphs to indicate that both consonants contained in the name of the hieroglyph are to be pronounced. See G. Æ. p. 11, 22 ; Pl. xxxi. 435 *a*, & Pl. xxi. 278.

165, 166. See 120, 148, 157.

167. See Pl. i. *c*. Ch. took the pedum for "corriger, ⲱϥⲉ," and for *h*, but it expresses *b* and *bk*.

168, 169. The figure of a web, not differing from that on Pl. ii. 1, and called ⲛⲟϭ (G. Æ. 112, Nos. 590, 591), expresses syllabically ϫⲛⲉ, generatio, progenies. The context says that Vespasian was taught to love the human race—literally, the nations (of the whole earth). The very same sense of the same group will be found on Pl. xvi. No. 207; in the R. S. v. 22 & xi. 23; T.S. xi. xii. xix. xxx. etc.; T. B. 82, 5; 149, 41; 32, 9, etc. etc. Deluded L. imagined the same group to denote Asia (T. S. v.), but Asia was properly the kingdom of Antigonus, and, in later times, Asia Minor, whilst in Vespasian's days a large part of Europe, Africa and Asia was subject to Rome, and Palestine could by no means be called Asia. This absurd interpretation of our group was adopted by G., and hence the strange interpretation that Vespasian was "the ruler of Asia."

170, 171. This frequently recurring group contains the words ⲕⲁϩ (terra) and טוף (tup), or rather טפטף (taptap), circuitus; for, instead of the two hills we find sometimes the finger ⲧⲉϭ, which demonstrates that the hill (ⲧⲱⲟⲩ, תו, tv) syllabically expressed *tb* or *tp*. The fact that, instead of two hills, sometimes only one precedes the figure of the mountains, explains itself by the use of both the Hebrews and Egyptians, to geminate a root, and then to extrude one of the radical letters from which the so-called words *mediæ geminatæ* originated. Comp. כב. כבכב. כוכב. kab, kabkab, kokab; עלה. kala, σάλλ, holocaustum. The image of the mountains (ϫⲱⲱϭⲉ) signifies *kb* (G. Æ. 35, 20), and hence expresses ϭⲟⲛ, כף (kap), vola manus. See further on No. 248.

172. See 84, 210, 102. G. combines the presumed *s* with the following figure in order to make out the word *suus*, his; but, alas! he knew not yet that the adjective always follows the substantive.

173 is not the letter *n*, as G. conceived, but the goblet ⲁⲛⲟⲧ, ⲁⲫⲟⲧ, a. ϩⲁⲛⲟⲧ; accordingly, denoting ⲉⲫⲟⲩⲧ, אפוד (epot). See Pl. ii. *b*. The latter signified not only the notorious ephod of the high priest, but also simulacrum, statua, because the statues of the ancient gods were like as if they were the envelopes of their faculties. Hence the signs of the Zodiac, i.e. the houses of the seven planetary gods, were termed πρόσωπα, adspectus of the gods. The pronunciation of this goblet, already fixed in G. Æ. p. 100, No. 522, contains the name of Abydos, a. Habydos (T.B.

1, 9; 17, 19; 18, 6; 64, 9; etc.), and is very often replaced by other hieroglyphs of the same value. See Pl. xxxi. 436, a. xvi. 205.

174. The figure of a blind man (ϐεⲗⲗε) groping along a road by means of a staff, expresses *bl* in *korbal*, corrupted Ἀρούηρις (see Yong's Hieroglyphics, Pl. 65), instead of Ὡρ-βηλ-ις (Pl. xxxi. 436, *b*). The same figure appears in the group בעל (baal), Ὢν (Heliopolis), i.e. the πολιοῦχος of On, and is frequently rendered by the synonyms ⲁⲧⲁ, validus; ϫⲱⲙ, validus; ϫⲟⲣ, fortis; ⲟⲩⲱⲗⲉ, mighty, etc. See T. B. 1, 23; 15, 35, etc.; 19, 14, 32, 1, 9, 41, 4, etc. St. L. T. vol. i. Pl. 5, 7, 6, 35. G. brings out "councellors," and puts the pronomen before the substantive, provided he did not designedly omit the words 172 and 173.

175, ϩⲏⲓⲓ, court, expressed by the notorious figure of the snake ϩⲱϐ. G. translates it by "did."

176. The star, called כוכב (kokab), כבכב (kabkab), corrupted ⲥⲓⲟⲩ (siv), furnishes the word "splendor." G. guesses the stars to signify "honor," in view, perhaps, of the stars of decoration.

177, ⲛⲁϣ, for the men, or everyone, and not "for me," as what follows clearly shows.

178—shamefully corrupted by B., who changed two letters—represents the well-known word ⲣⲁⲛ-ⲩ, in Coptic ⲩ-ⲣⲁⲛ, placens, beneplacitum. G. discovers this group to signify "he gave," since *rn*, in his dictionary, mean "to give."

179. See 177.

180. The clew being called ϩⲟⲛⲧ (Pl. vi. 66, xix. 251, xv. 198, xii. 154; G. Æ. p. 111, Nos. 585, 586) and the horns, ⲧⲁⲣ (G. Æ. 57, 219) form the word ϩⲟⲧⲛ, combinare, creare, and not "the post," as G. fancied.

181. See Pl. iv. 30. G. takes the handkerchief, ⲕⲁⲓⲥⲓ, for "chief," perhaps by a Mexican trick.

182. See No. 30. G., of course, brings out "priests," although no sign of plurality is added.

183. See No. 31. Ch. and L. pronounce this group "Pacht," and now we have to spell "Sechet," a city down to this day totally unknown,

184, 185. This frequently occurring group simply contains the letters *hs tp*, i.e. ϩⲓⲥⲉ. Isis, and תו (thaf), from the root תוה (thafa), habitavit, habitatio; for from the Hebrew כסא (kisse), the Coptic ϩⲓⲥⲉ, the throne originated, and "Isis" signifies properly "pulchra," preserved in the corrupted words ⲥⲁ, ⲥⲁⲓ, ⲁⲥⲱ, ⲉⲥⲉ, a. ϩⲉⲥⲉ, pulcher. See G. Æ. p. 90, No. 454. The following letters, *tp*, refer to תוח (thafa), related with ⲑⲃⲁⲓ, תבה (thebah), cella. Accordingly, our earth was considered to be the home of beauty. G. translated it "Es-Senem, the Isle of Bigeh," perhaps discovered by himself.

186. G. craftily conceals that he was unable to translate the groups 186 and 187. Perhaps, however, the printer may have overlooked "..........." The former group represents an arrow, ⲕⲁⲧⲉ, the corrupted ⲉϩⲧⲏ, ⲥⲁϯ, related with גדד (gadad), incidere, which furnishes the word חטה (chitah), triticum, the corrupted ⲥⲁⲧⲉ. The very same signification will be found on the T. S. xxxiii., where L., imagining that, according to Ch., the word ϫⲉⲙⲉ (spica) must be followed by the ideologic figure of an ear, transformed the arrow into an ear.

187 represents the vulture, which, according to Horapollo i. 11, signified mater. Indeed it expressed *m* in χνου-μις, etc. (G. Æ. 66, No. 282), also *mt* in ⲙⲁⲧⲉ, possidere (I. R. x. 12; Philæ-door l. 15, translated by κύριος), in Philometor, in ⲙⲛϯ, Cancer, etc. See Pl. xxxi. 337, *b*. Hence the vulture represents the goddess Muthis, or Methuer, our "mother," Germ. Mutter, viz. the earth, the mother of all.

188. Since the crying mouth, ϫⲁⲣⲁ, commonly expresses *kr*, *kl*, we have the word כֹּל (kol), ϫⲱⲗ, all. See Nos. 134, 147, 221, 432, *a*. G. imagines this group to signify *mr*, "chief," but no such word exists in any language.

189, 190. See 29, 31.

191, 192. The ligature of the reed σάρι (kari, 142, 377, 422) i.e. *kr* with the city plan, ⲃⲁⲕⲓ, expresses in numberless places the country south of the Delta (ϭⲉⲣⲉ, צהר, ⲃⲁⲕⲓ, the bright country.) The other ligature, containing the papyrus-plant ⲕⲁⲙ, גמא, gome), signifies the dark country (ⲕⲏⲙ, חום, chum. ⲃⲁⲕⲓ), i.e. the country north of Memphis, but, in general, the northern countries of our globe. G. takes it easier in translating "the double land," viz. of Egypt.

193. B. shamefully transformed the figure of a beater into that of a blind man, or pilgrim, holding a walking-stick in his hand. It is probably for this reason that G. interpreted it "chief," sym-

bolically according to Ch. But, alas! the beater expresses the same syllable signified by the beating arm, viz. *ht*, ϩⲓⲧⲉ, ferire (G. Æ. 52, 178), to the effect that the words ϩⲓⲧⲉ, to spin; גיד (gid), חוט (chut), related with ϩⲟⲉⲓⲧⲉ, a woven stuff, are spelled out, and not a "chief."

194. The flower or bouquet standing very often for the cony, called cuni-culus, Germ. Kaninchen, Ital. coniglio, etc., even in the same words, it is natural that both glyphs must express the same sounds. See Pl. XXXI. 437, *a*. Now, the bilingual coffin of Turin expresses *k* in κενεβώς (wrongly spelled βενεβώς by San Quintino in Transactions of the Turin Academy, 1825) by the cony, and the Philæ-door applies the same cony for *k* in *kn* (καινός); accordingly, the bouquet must have been called ⲕⲁⲛ, the corrupted ⲓⲁⲛ, flos, viola; which is confirmed by Plutarch (de I. c. 37, p. 365), saying that Χεν-όσιρις means φυτὸν Ὀσίριδος. Consequently our group (ϩⲓⲧⲉ, i.e. ϩⲟⲧⲉ, pudendum; ⲕⲟⲩⲛ, penis) signifies pudendum virile. Our Ch., on the contrary, renders it "of the park"; and it would be very interesting to learn in what language *htkn* stands for "park."

195. The foot (ⲡⲁⲧ), it is known (G. Æ. 55, 206), signifies syllabically *bt*, and hence the word בד (bad), related with ⲟⲩⲱⲧ, separare, membrum. The added ⲁϣ, איש (ish), gives membrum virile. G., being unable to interpret this group, forgot to mark it by "........."

196, containing the well-known letters *mak*, refers to the root ⲙⲟⲕⲙⲉⲕ, related with מח (moak), cerebrum, and furnishes the word "excogitavi." G. translates "didst defend," a wonderful divination.

197, ⲛⲁⲕ, for thee, and not "thou," as G. would have us believe, because the case-sign is added before *k*.

198, the before-mentioned clew (ϩⲟⲛⲧ) or thread בד (bad), the corrupted ⲟⲩⲁⲧϩⲓ (Nos. 16, 180, 154), which, determining the names of all human limbs by בד (bad,) signifies both "thread" and "limb." See e.g. T.B. Pl. XIX. 42; Description de l'Eg. v. 25; Papyrus Minutoli; The London Museum, No. 2. G. translates our group by "didst," which is one of the choice specimens of his immortal translations.

199, representing the act of fighting, ⲙⲓϣⲉ, involves syllabically ⲙⲁⲥ, matrix, as the premises require. The same signification of the group occurs very often, e.g. T. B. 1, 1; 3, 17; 7, 8. Our Egyptologist translates, of course, "in the battle." Such are the fruits of the world-renowned system.

200, the papyrus-plant, ⲕⲁⲙ, ϫⲱⲙⲉ, גמא (gome), containing *km*, and hence signifying ϫⲙⲉ, to generate, populate. See Nos. 192, 36, 47.

201, 202. Inasmuch as the bowl (see 11, 39, 44) expressed the syllables *kl*, *kr*, we have the words χώρα, גור (gur), region, and כל (kol), all. Yet Mr. G. informs us that the last three glyphs signify "the Greeks." This wonderful interpretation is based on L.'s very wonderful translation of the T.S. l. 37, viz.: the Greek text says that the priestly resolutions were to be promulgated in hieroglyphic, Egyptian and Greek letters; and the R. S., concluding with the same order, calls the demotic text γράμματα ἐγχώρια, domestic letters, instead of Αἰγύπτια. Now L., being unable to spell the group signifying Ἑλληνικός, and containing the letters *krks* (Græcus), interprets the latter by "the letters of the books," i.e., according to his capacity, the Egyptian or domestic letters. Consequently the resting group must signify "Greek." This was, of course, a hard nut; and yet the art of guessing overcomes all difficulties. The bowl, says L., signifies the abbreviated word ⲛⲓⲃⲉⲛ, i.e. ⲛⲓⲙ, and the Coptic name of the Greeks was ⲟⲩⲉⲓⲛⲓⲛ; consequently our group signifies the syllable ⲛⲓⲛ in ⲟⲩⲉⲓⲛⲓⲛ, Græcus, by the figure of the bowl ⲛⲓⲙ. It is true, ⲛⲓⲙ and ⲛⲓⲛ differ a little, but such trifling discrepancies, L. says, make no difference. Finally, the preceding figure of the papyrus-plant (ⲕⲁⲙ, גמא. gome) *must* have been pronounced ⲟⲩ, because the group *must* express ⲟⲩⲉⲓⲛⲓⲛ, Græcus. The papyrus always expresses *k* and *km*, and nowhere *u*; but it *must* rather have been pronounced *u*, say the Champollionists, for the reason that it expressed *u* in ⲟⲩⲉⲓⲛⲓⲛ. Such is the present method of forming logical deductions. Moreover, the T. S. uses the figures of papyrus and three bowls for expressing the regions of Egypt, whilst the Pompeian Tablet puts only two bowls (signifying duality), and hence at that time two Greek nations were in existence. Is not that strange in the extreme?—From this πρῶτον ψεῦδος it was concluded that figure 199 represented a battle, and that the person concerned (Vespasian) fought "the battle of the Greeks," apart from all other absurdities. The fact, also, that the R. S. and the T. S. call the demotic letters only the Egyptian literature proves that the hieroglyphic literature of the Egyptians was of foreign origin. This is confirmed by Cassidor (Chron. ad Theodor. Reg.): "Obeliscorum prolixitas," says he, "ad Circi altitudinem sublevatur, ubi sacra priscorum *Chaldaicis signis*, quasi literis indicantur." Accordingly, the hieroglyphic method of writing was not invented in Egypt; it must have existed prior to 2780 B.C. (666 years after the deluge), in which year Menes and the first inhabitants of Egypt settled in Tanis; it existed already in Chaldæa. And hence it comes to light that the literature of the Chinese and Japanese, as I learned from the late missionary Guitzlaff, was a syllabic writing like the Egyptian, and that the said nations expressed by the figures of natural objects the consonants of other words, which contained the same consonants in the names of the respective images, just as the Egyptians.

203. See 171. The sign of plurality, ות. refers to the preceding substantive, as usual. As the image of mountains, according to Ch., portrays the preceding group to be the name of a city or country, G. ought to take his "Greeks" for a city, which would have been nonsense, and therefore he prudently omitted to mention this so-called determinative.

204. The figure of a hamper, כלוב (klub). Germ. Korb, corbis, signifies *k* in ϫⲟⲗ, *συναγωγή* (T. S. xviii.), ϭⲁⲣⲟ, אחר (achar), *ἀπό* (T. S. xv.), *ἐπεί* (R.S. x. 19), etc. See No. 35. G. brings out "when," a new interpretation of our group.

205, misrepresented by B., expresses the notorious letters *hpt*, i.e. ϩⲟⲡⲧ, concinnare, creare; for the first sign is another form of the goblet, Nos. 6, 173 (see G. E. 117, No. 614), signifying *h* in Abydos, a. Habydos (436). The eared-snake, ϩⲟϥ, *ὄφις*, gives *p*, and the arm with the club, ϩⲓⲧⲉ. signifies *t* or *th* in *Θαχέλοφις*. G. discovered this group to signify "smite," probably according to a dictionary of his own.

206, ⲛⲟϭ. great, like Nos. 130 & 139, and not "thou," because the pronoun never follows the verb.

207, 208, 209. See 169–71. 210. See 84, 102, 114.

211. The sickle being called ⲙⲁϭⲟⲩⲗ. like מגל (magal), *μάχαιρα*, Germ. Messer, it is natural that the letters *mkr* and *mk* should be expressed by the same image, e.g. in מג (mag), ⲙⲁⲕⲓ,

the city of *Μάγω* (Pl. xxxi. 438, *b*); *μακάριος*, מג (mag), beatus (Pl. xxxi. 438, *a*); עמק (emek), as the T.S. bears witness (l. ix.) See Pl. xxxi. 459, *a*. G. omitted to mention by "........" that he was unable to translate the groups 210 and 211.

212, consisting of a knife and a beating arm, is to be spelled *krt;* for the latter, ϩιτε, ferire, expresses *ht* and *t* (Nos. 205 & 193), and the knife, called σορτε, כרת (karath), culter, cutter, r. כור (kur), כרא (kara), כר (kar, cæsor), σρн, (arare, fodere), expresses *kr* in many words, e.g. גרה (gerah), the corrupted ϩιρ, granum (T.B. Pl. xli.); in *κύριος*, σοιλε-ερπε, templum (see R.S. x. 36, Pl. xxxi. 440, *a*); in כרת (karath), σορτε, *ἐγκαλάπτεσθαι*, *ἀναγραφάτωσαν* (T.S. xii. xxxvi.; see Pl. xxxi. 439, *b*); in σλωτ, intestina, Germ. Kald-aunen (T.B. xix. Tit.; see Pl. xxxi. 440, *a*); in *kr kr*, Heracleopolis (see Pl. xxxi. 440, *b*); *k* in *κῆτος*, σωτ, צור (kud), cetus (Pl. xxxi. 440, *b*), etc. G. translates it "killed," because the knife, ideologically, signifies "to kill."

213. See 135. G. brings out "they," in spite of the Egyptian syntax.

214. This group, as we have seen (Nos. 122 & 156) signifies "a multitude of charms," but this general meaning does not agree with the specific object of valleys and glens; wherefore the involved letters *mk kr* probably refer to ιορ, rivers, particularly because these works of the Creator are not mentioned elsewhere. At least ιορ is the corrupted *Γόρ*, the name of the Nile being Giris, i.e. river, as Plin. Diog. Perieg. v. 221, reports. The gutturals very often go over to the consonant *y*. See p. 203, 3, etc. G., not caring about the names of the hieroglyphs, translates our group by "many."

215 signifies, as is well known, a dual, owing to the *two* ostrich feathers. The latter, being followed by the word καϣϯ (the constellation of Leo), L., by the instrumentality of his disciple Gensler (Thebanische Tafeln d. Sternaufgaenge etc., Leipz. 1872), translates, "the two feathers of the giant," a wonderful new constellation in our starry heavens. But, alas! the feather, μαϩι, expresses μαϩι cubitus Leonis, as in Kircher Scala and all Coptic dictionaries will be seen. Consequently L. ought to have translated, "the two Cubiti Leonis." G. knew that, but he could not, of course, translate, "they killed many of my two feathers," and thus he did not hesitate to change the dual into the plural,

and *mahi*, without any reason, into "friend." I cannot decide which nonsense, whether that of L. or of G., is the greater.

216, the familiar suffix "I," like the Hebrew (G. Æ. 38, 43), and hence the natural sense is obvious, "I the Almighty build the valleys, their glens, the many rivers, with my own arms," instead of "they killed many of my companions."

217. See 101, 109. G. returns to the chimera that the Egyptians expressed "not" by the letters *hpt*.

218 signifies, according to G., "he (the enemy) raised not his hand against me." But the eared-snake (ϩⲱⲃ) cannot mean "he raised," particularly since it returns after the following word. In both cases ϩⲱⲃ the snake furnishes ϩⲱⲃ, to make.

219. The eagle ⲁϩⲱⲙ, a. ϩⲁϫⲱⲙ (G. Æ. 67 & 285), and the bearer of a goblet, ϩⲁⲛⲟⲩ (G. Æ. 42, 85), with the arm, אמה (amah), give the word *hpa*, i. e. ϩⲟⲡⲓ, related with ϩⲏⲛⲛⲉ, and ὠπή, face, אף (ap), face, give facies. G. promulgates the new word *ab*, i.e. arm, owing to its figurative determinative, "arm."

220. See 220. G. takes it for the suffix ו, his.

221, 222. The following hieroglyphs specify the different limbs of the human body, created by God. In the first place, the human mouth; for the crying mouth ϫⲁⲣⲁ carries the corrupted ϩⲣⲁ, ⲣⲁ, os, and the figure of a man איש (ish), ⲁϣ expresses "human." G. regales us with the nonsense, "against me."

223. Both the eyes, *al*, i.e. ⲁⲗⲟⲩ; the dual expressed by the hill ⲧⲁⲩ (tav), signifying δύο, duo, two, as we have seen (No. 64). G., on the contrary, inserts authoritatively "his," and takes the eyes ideologically, whilst the first signifies *a*, the second *r* or *l*. In a very similar way two arms express *amh*, ⲁⲙⲁϩⲓ, e.g. on the Tablet of Abydos, where all royal names are preceded by the words *melek amahi*, the mighty king. A similar example will be noticed in T. B. 6, 2; 75, 12.

224, the word בד (bad), limb, spoken of in the premises (No. 198), is a substantive, because the following bears the sign of the genitive, ⲙ. Nevertheless G. copulates the hill with the clew, and tries to impose on his readers that *to* signifies "were."

225, of the arms, signifies "dull," but it is totally unknown to me in what language, according to G., *maa* means "dull."

226. The figure of a track, ϩⲓⲛ (G. Æ. 37, 39) expresses *hi* and *e*, e.g. in the word ⲏⲧⲉ (Pl. xxxi. 232, *b*), and the pullet,

ϩⲁⲛⲟⲧⲓ, expresses the corresponding letter. Hence we have ϭⲟⲩϩⲉ, the eye-lashes, the track being put before the pullet for the purpose, as usual, of filling a void place. G. wonderfully fetches out "afterwards," and cunningly conceals from the eyes of his readers, that, by means of Ch.'s discovery of "the key to Egyptian literature," it is impracticable to decipher the following three words, Nos. 227, 228, 229.

227. The name of the eye-lashes, ⲕⲁⲛⲉ-ϥⲱⲓ, cilia, consists of the word ϥⲱⲓ, hair, and ⲕⲁⲛⲉ, i.e. ⲥⲟⲛϩ, cingere, cingulum — the Greek ζώνη, cingulum — and hence ⲕⲁⲛⲉ-ϥⲱⲓ signifies properly a girdle of hairs, corresponding with eye-lashes. From the T. B. 18, 33, and 19, 11, we learn that the same figure, a little differently delineated, was called ⲉϫⲛ, supra (see Pl. xxxi. 441, *a*), where it is the participle of a verb (ϫⲛⲁϩ-ⲛⲟⲩⲧ). The latter is put beyond question by No. 347, where the same word (eye-lash) signifies ϫⲛⲁϩ, suppressor. Accordingly, this eye is not an ideologic representation, but, as Clement says, κυριολογεῖ διὰ μίμησιν —it pronounces mimetically, and yet syllabically.

228, called ⲕⲁⲣⲁ, expresses *kr* in numerous places, and here the word ϩⲓⲣ, pupilla, the next to the eye-lashes. G. A. 44, 115.

229. The coffer, קב (qab), cupa, כוה (kafah), cavus, גבב (gabab), signifies *kb* (159, 444, *b*), hence the nose, גב (gab), ⲥϭ (in ⲥϭ-ϣⲁ, naris), literally curvitas (nasus), the next limb to the eye-lashes and the pupil.

230 represents, as we have seen (Nos. 90, 41, 14, 9; G. Æ. 79, 377), *bt*, and hence the word ⲟⲩⲱⲧ, the Greek οὔατος, ear. Peyron's Dictionary presumed ⲟⲩⲱⲧ to signify the fat of the ear, the earlap; but ⲟⲩⲱⲧ, as the Greek οὔατος, the corrupted οὖς, evinced, was the real name of the ear. G., joining the salad with the ansated bowl (No. 231), translates "thy majesty," viz. according to the great Champollionist B.

231. The ram-headed man with the ostrich feather, ⲙⲁϩⲓ, as we have seen (Pl. i. *a*, *a*[1]; Nos. 58, 122, etc.) signifies the mighty El, and with the suffix *k* (tuus) thy mighty god. G., not knowing what to do with the ram-headed figure, omits to mark by "........" that he could not solve the Champollionistic riddle.

232, likewise omitted by G., expressed by the figure of the skull (ⲕⲁⲣⲁ), the word גל (gal), i.e. too, furthermore, as the context shows.

233. The viper being termed ϫⲉⲧ (see annotations to 48, and

G. Æ. 73, 328), we get the word κωτ, formare. G. brings out "(thy majesty) spoke (to me)."

234 is notoriously אִישׁ (ish), ⲁϣ, the man, and not "I," as G. imagined.

235. Remembering that the door-bar, ⲉⲃⲉ, expresses *sb*, *sp* (114), and the feet ⲧⲟⲟⲧⲉ, *t* (141; G. Æ. pp. 56, 207), the word ⲥⲁⲡⲧ, eligere, is easily made out, which with the preposition ⲉ̇ (ad) gives ad electionem, especially. G. elicits "go," and he alone knows in what dictionary *asi*, as Ch. spells it, signifies "go."

236. As the crying mouth, ϫⲁⲣⲁ, expressed *kl*, *kr* (Pl. ii. 1; G. Æ. 48, 143), the word ילך (yalak), a. גלך (galak), the Coptic ϭⲁⲗⲟϫ, thigh, leg, from the root גלך (galak), ϭⲁⲗⲟⲕ, ire, comes out. G. invents the word "thou," expressed by the letters *rk*.

237. In consequence of the pullet being called ϩⲁⲡⲟⲧⲓ (83), the word ἐπί (ad, secundum) naturally results. G. had to spell "to." The same group very often signifies ἐπί on the Tanis St.

238, *kr*, κύριος, as we have seen (142), and not at all the abbreviated word *suten*, as Ch. and G. fancied.

239, 240. The child being called κόρος, גור (gur), גול (gul), G. Æ. 38, 44, it is natural that it frequently stands instead of *kr*, and expresses the same letters in different words. See Pl. xxxii. 442, *b*. For example, the child signifies *kr* in ⲧⲁϫⲣⲟ, T.S. xxiii.; in ϫⲓⲣ, T.S. ix.; ϩⲁⲣⲉϩ, T.S. ix.; in ϫⲉⲣⲉ, T.S. xvii.; ϩⲣⲁ, קרא (kara), T. S. xxxiv.; ϫⲁⲣⲁ, T. S. xxxiv. xxxiii.; ϫⲉⲣⲉ, T. B. iv. 34, xii. 45, viii. 54; ϫⲏⲣ, T. S. xviii.; ϫⲉⲣⲉ, xxxvi.; καιρός, P.D. i.; ϫⲣⲉ, T. S. v., עקר, T.S. viii., etc. etc. Hence the child followed by *nn* expresses *krnn*, i.e. the Doric κοίρανος, the corrupted τύραννος, originally "dominus, princeps," and in later times "a tyrant." The Greek τύραννος obviously originated from the Egyptian ⲟⲩⲣⲟ, king, and ⲛⲛⲛ, elatus; many Greek words, as Herodotus witnesses, having originated in Egypt. Moreover, even the Scholiast ad Soph. Œd. Tyr. reports that τύραννος was first introduced in the age of Archilochus. See Schneider's Greek Lex. s. v. The following map of a city, or *tellus*, furnishes accordingly the words "the king autocrat of the world." Poor G., like Brugsch and all other blind followers of Ch., imagining the map of a city to signify ideologically a city, and the child to express *s*, translates, the city of "Suten-Senen," a place mentioned by no ancient or modern author. Since G., however, has seen with his own eyes that "Suten-Senen" was ancient "Heracleopolis," we have to be thankful for this discovery. And this chimera is reproduced twice more in Nos. 311 and 271. Indeed such absurdities would be amusing were it not for the painful consideration that men of education, after taking upon themselves to give instruction in useful knowledge, have failed, during a period of fifty-four years, to learn the Egyptian ABC, or to abandon their master's charlatanry.

241, *mk*, referring to the root מח (moach), brain, agrees with ⲙⲟⲕⲙⲉⲕ, meditari, excogitare. G. brings out "be thou diligent," probably taking the ansated bowl for "thou" and the syllable *ma* for "be." Remember that Ovid likewise praises the upright walking of the man, and that he was made "in God's image."

242 is the well-known toe called ϩⲓⲧⲉⲛ, i.e. ϩⲓⲧ–ⲉⲙⲉ, which expressed *ht* (G. Æ. 53, 189), e.g. in ϩⲟⲧⲉ (ⲛ)ⲟⲩⲛⲟⲩ, hora (Pl. xxvii. 442), and here, as the context argues, ϩⲟⲧ, capsa. The same signifies *ht* in ϩⲱⲧ (T. S. vii. xviii., where it is rendered by ⲉⲙⲛ, et, demotically; xxvi. xxviii. etc.) G. shamefully omits to mark by .... that he could not interpret this figure, much less the following four groups.

243. The open mouth (ϭⲁⲣⲁ) signifying *kr*, e.g. in Chaldea (Pl. xxx. 416), gives with the following *k* the word ⲕⲉⲗϫ, the leg.

244, representing ⲉⲛⲛⲛ, hackled flax, signifies the letters *sb*, *sp* (Pl. ii. 5; vii. 84; ix. 102; xiii. 172; xvi. 210; xix. 282); accordingly, ⲥⲏⲃⲓ, fistula pedis.

245. The familiar ⲙⲟⲩⲧ, junctura filorum (see G. Æ. Pl. 47, Nos. 589, 590, and No. 65 in the premises), involves the syllable *mt* in very many words (G. Æ. 113, 502); accordingly, ⲙⲟⲩⲧ, the shoulder, or rather, owing to the following ⲧⲟⲧ (manus), ⲙⲁⲧⲉ, related with ⲁⲙⲁϩⲧⲉ, מדה (madah), robur, the upper part of the arm.

246. ⲧⲟⲧ, the hand, signifies *tt* very often. T. B. 15, 18; 17, 58; 42, 11. See Pl. xxxii. 443, *a*.

247. See 235, 269. G. discovers the feet to signify "traverse," because the feet, according to Ch., symbolize walking, which does not differ from "traversing."

248. See Nos. 203, 171; G. Æ. 35, No. 20, *a*. The three figures represent plurality, because the palms both of the feet and the hands are meant. G. brings out "the countries."

249. See No. 7. Pl. xxx. 414, *b*. G. translates the figure by "alone," and yet the same figure (No. 7) signifies "javelin." I feel unable, I confess, to tell by what *hocus-pocus* it was discovered that the weaver's shuttle represents both "javelin" and "alone," of course ideologically.

250 is not *a*, nor mimetically arm, but the syllable אמה (amah). the Coptic ⲙⲁϩⲓ, to the effect that two arms express ⲁⲙⲁϩⲓ (mighty) on the Tablet of Abydos repeatedly: מלך (melek) ⲁⲙⲁϩⲓ, the mighty king. See Pl. xxx. 444. G. translates the arm with the clew "by thyself," but this singular interpretation, I am sad to say, surpasses my capacity.

251. See 66, 154.

252. See 108. The context proves that the elbow was under consideration, of which the names ⲕⲁⲗ-ⲁⲛⲕⲁϩ, ⲕⲉⲗ-ⲛⲕⲁϩ, ⲕⲉⲗ-ⲉⲛⲕⲉϩ (r. ⲕⲉϩ, brachium) contain the same letters ⲕⲉⲗ, flexio. Since the peruke alphabetically signifies *k*, G. took it for the suffix *k*, thou, "thyself."

253. See 99. Bark being called ϫⲟⲓ, a. ϫⲟⲟⲩⲓ, like צי (ki), a. צו (kiv). r. צוה (kava), cippus, expresses *kb;* hence ⲕⲱⲃ, texere. Comp. Nos. 29, 84, 114, etc. According to G., the nonsense comes out, "I embarked."

254 is the well-known suffix of the first person, I (G. Æ. 38, 43), like the Hebrew I, appended.

255. The notorious papyrus-stalk ⲕⲁⲙ, גמה (gome), signifies *gm*, *km* (Pl. i. d'. iv. 36, etc.), and hence ϫⲟⲙ, like the corrupted Hebrew ים (yam), lebes.

256. The Egyptians, as well as many other nations, distinguished the sexes of pigeons by different names, calling the male one ϭⲣⲟⲙⲡⲓ-ϣⲁⲗ (tur-tur), תור (thor); the female, ⲃⲁⲗ. For ϭⲣⲟⲙⲡⲓ, ϭⲗⲟⲙⲡⲓ (glompi), is simply the Latin columba, and ϣⲁⲗ (Germ. *Schall*) is the corrupted ϩⲁⲣⲁ, קרא (qara), vocare; literally, columba vociferans, turtur. See G. Æ. 70, 309. Poor Ch. and all his followers imagined the dove constantly to signify *u*, and why? Because the god Aroeris is expressed by a sparrow-hawk (*kr*) and the pigeon, followed by the mouth. But, alas, the syllable *eris* is the corrupted *ber*, as the same name (κύριος, Baal) represented in Yong's Hieroglyphics (Pl. 65), establishes. See Pl. xxxii. 445. Accordingly our Chst. discovers the new city "Uat-Ur"; and this city, as he assures us, was set forth, "Pehu of

1st N. E. Nome." Every sane reader will now understand that Nos. 255 and 256 grammatically signify the bladder, "the vessel for emitting water."

257. See 94. G. prudently omitted to mark by .... that he could not explain the water.

258. See 253. This figure again signifies "not" according to G.

259. Everyone perceives the figures in No. 259 to contain a synonyme of the group 254, involving the notion "I created." Indeed this roasted goose, called after the root ἔπτω, ἔπω, ἕψω, *assare*, expresses the name of a king on the Berlin papyrus No. 1558, and the Turin Maneto mentions the same king of the 5th Dynasty, translated Ὄθυος (r. Ὄθτνος). See Pl. xxxii. 443, *b*. Peyron correctly translates: ωτ n ωϐτ, fat of the goose. In short, our group signifies ϩοnτ-ι, I combined. G., on the contrary, makes it read "(not) I feared," perhaps because all geese fear to be roasted.

260. The gander, as we have so often seen, called nen-eeooe, furnished ϭοnϩ, the Greek ζώνη, the girdle. Comp. Pl. xxx. No. 423, *b*. G. takes this goose for "difficulty," probably by means of an unknown Mexican puzzle. Besides, he forgot to indicate by ... ... that he could not interpret the following group (gut, ile).

261, misrepresented by B. by omitting the article ne, obviously represents gut, ile, ϩnτ (colum), accompanied with the suffix *k* (thy). Hence the same figure expresses the constellation Serpentarius, ϫατ-ϭαn (i.e. the catcher of the two serpents). See Pl. xxxii. 444, *b*.

262. See 258, 253, etc. Again G. translates "not."

263 is apparently a synonyme of Nos. 259, 254, 241, and hence we obtain the word τeϐ, fingere, or ταϯο, proferre. For the hill ταϯ, תף (thaf), expresses *tb*. See Nos. 164, 170, 208. G. imagined this hill, either alone or copulated with the following chamber, to signify "I obeyed"; but, his dictionary not yet being published, nobody is able to tell on what basis this chimera rests. Besides, he again prudently omitted to indicate by dots that he failed to translate the following *three* words.

264. See 146.

265. Since the knife, כרת (karath), expressed the correspond-

ing consonants, and since the leg σλωτ (ren, νέφρος, testiculi) contains the same consonants, no doubt the two testiculi were intended to be portrayed, particularly the scrotum preceding. It would be less probable that the kidneys were referred to.

266–7. These well-known letters give: ϩ ϩετ-κ, on thy belly. G. translates ϫοτ, dicere, by "preceptum."

268 properly represents a weaver's reed, pecten (a comb), κλλ (Pl. xxxii. 444, *b*), i.e. the bones of the feet and hands resembling a comb. G. guessed this pecten, followed by the determinative feet, to mean "I reached." But, alas, of the word "I" no jot is visible.

269. See 141. 270–72. See 238, 271.

273. See 262, 258.

274 represents the traces for attaching horses, יתר (ither), and the feet, which contain the words τωρ-ϯ, I planted. For the traces express very often *tr*, e.g. in כפתור (kaphthor). T. S. l. ix. The appended feet furnish the notorious ϯ and תי (thi), which, being appended to verbs, form the first person I, both in the Coptic and Hebrew languages. Accordingly we have to translate: I fixed, or planted. G., on the contrary, not knowing the name nor the syllabic value of the traces, spells out "not" (instead of further) "was hurt" (instead of, I planted), probably on account of the singularity of his Coptic Dictionary.

275 is not a figurative symbol of the hairs, but the phonetic word קף (qaf), the Latin capillus; wherefore it expresses *kb* very often, e.g. on the T. S. xxvi. & xxix.: כאב (keab), the corrupted ϩηϭε, lamentatio, πένθος.

276, the notorious cranium, κλρλ, from the root גל (gal). גר (gar), never expresses *h*, as the Chts. imagine. Hence G. translates the passage "of"; together, "not was hurt a hair of my head." But, unfortunately,

277 is not "my head," but the verb κλϭ-ι, I wisely excogitated. For the head is the Hebrew קוף (qop), the corrupted λπε, a. κλπε, G. Kop; and it stands for *kp* (Pl. xxxii. 445, *b*, and frequently expresses *kp*, e.g. ϫεπ, חב. R. S. i. 8. See T. B. 40, 4, 5; 44, 4. 5; 44, 3; 71, 13; 80, 2.

278. The lion's claw, called ϫλμη, expresses *km* in many instances. See G. Æ. 61, 249; particularly St. L. Tr. i. 534 & 544. Our Egyptologist, on the contrary, being affected by Ch's idiocy,

that the lion's claw must signify "beginning" for the reason that it is the first part of anything, brings out "the beginning," instead of ϫωⲙ, kettle (of the brain). Is that not wondrous in the extreme?

279 is obviously the Hebrew מוח (mok), related with the Coptic ⲙⲁⲕ-ⲙⲉⲕ, cogitare, but, according to G., "observed."

280 points us to the root ⲛⲟⲩ, currere, cursus, from which perhaps the abbreviated words ϥⲱⲓ, ϥⲟ, ⲃⲟ (canalis), descended. ⲙⲁ ⲛⲟⲩ (locus currendi), therefore, signifies the place of running, similar to ⲙⲁ ⲛ ⲧⲥⲟ, ⲙⲁ ⲛ ϩⲁⲁⲧⲉ, canalis. G. elicits "in accordance with that," but nobody can tell for what reason.

281, the notorious nablium, נבל (nebel), pitifully deformed by B., in numberless places signifying ⲛⲟϥⲣⲓ, ⲛⲟⲩϥⲓ, ⲛⲓϥⲓ, respiratio. See G. Æ. 95, 493. G. cunningly concealed that he could not translate Nos. 281 & 282.

282. See 5, 172, etc.

283, altered by B., represents, clearly enough, cavitas oris, together with the uvula, חך (chek). ϭⲁϭ, wrongly translated by Kircher, "collum." For the T. B. (Pls. lxxv.–lxxviii.) specifies a number of interior parts of the human body, and there we see also the figure of the same mouth's hollow. Moreover, the figure combined with a bowl, containing (in its midst or below it) a kernel, served very often on the R. & T. Stones for expressing πανήγυρις. To-wit, the cavity ϭⲁϭ signifies syllabically *kk*, and hence חג (chog), festivity, whilst the bowl *kl* (No. 87) with the kernel *el* gives *kll*, i.e. ϭⲗⲓⲗ, כליל (kalil), burnt-offering. The group is sometimes preceded by the letters *hpt*, i.e. ϩⲟⲩⲧ, assembling (on a sacrificial festivity). See Pl. xxxii. 446, *b*. The poor Ch't presumed this ligature of six letters to signify ideologically a sacrificial convention, and yet G. brings out "hadst commanded," according to his unparalleled divination.

284. Since the following groups specify other parts of the mouth, we perceive at a glance that the letters *nk* refer to ⲛⲁϫⲉ, the teeth. G. holds *nk* (*tibi*) to express *tu*, thou.

285. The notorious tail of a lion, ϭⲁⲧ, corrupted ϭⲁ(ⲧ)ⲉ, ⲥⲁⲧ, Lat. cauda, related with גדה (gada), finis terræ, or קץ (qek), finis, expresses with the following letters *hi* the word ⲕⲱϩⲓ, vagina, swallow. As the tail, however, is the last part of an animal, G. says it must signify "in the end." That is stupendous! Is it not?

286, notoriously containing the letters *tnk*, is, as it seems to me, to be referred to the root tone, related with tonitru, τόνος, tonus, sonus, ⲥⲉⲛⲥⲉⲛ, sonare, etc., originated from τένω, extendere, an extension uttering a tone. For the board of a balance, involving the idea expendere, judicare, דין (din), frequently yields *tn* on the T. and R. Sts. תנה (thanah). See T. S. xxxiv. xxxv. xxiii. etc. G. translates the group, " thou gavest me"; but the suffix *k* appended to the verb signifies *dedit me*, and not *dedisti mihi*. So very familiar with the Coptic is our Chst.

287. The mallet, called ⲕⲉϩⲕⲉϩ (see Nos. 31, 190), gives with the following arm the word *ka*, i.e. ϫⲉ, emittere, related with יצא (yaka), exire, Hiph. educere. G. translates the following six words (287–292), "a long space of repose," which is not only pure guesswork, but even pure nonsense. Being unable to decipher these groups, he, no doubt, neglected a number of them, and probably took No. 287 for " space," or " long."

288, representing the solar disk *kr* (Nos. 70, 64, 43, 127), gives ϫⲉⲣⲉ, קרא (qara), words, oratio.

289. See 62, 167. The letters *kb* give ϫⲟⲟⲩ (kon), canticum.

290, the figure of joyousness. See 156, 122. G. takes it probably for " repose."

291. B. shamefully transformed the bean into a chain. The ancient name of the bean being ⲕⲟⲩⲣⲟ (comp. ⲟⲩⲣⲟ, a. ⲕⲟⲩⲣⲟ, κύριος, Horus a. Κόρος, ϩⲣⲁ, ⲣⲁ .a. *kur*, in Κύρος, etc.), the corrupted words ⲟⲩⲣⲱ (ⲕⲟⲩⲣⲱ), ⲁⲣⲱ, ⲁⲗⲓ (ⲕⲁⲗⲓ), expresses *kl*, *kr*. Hence *kr* in the name Βόχαρις was expressed by the same image of the bean. See Pl. xxxii. 447, *b*. The same bean represents *k* in ϫⲟⲙ, ϫⲉⲙϫⲟⲙ, potens. T. B. 15, 28. 86, 1, 136, 14, etc.

292. See Nos. 148, 143, 92. G., as it seems, translates the heart by " repose."

293. See No. 55. G. again translates " O !" instead of I.

294. See Nos. 22, 182, 184. G., of course, translates "priests."

295 does not express *neb*, all, as G. imagined, but *kr*, as we have seen (Nos. 39, 44, 51, 56, etc.), i.e. κύριος.

296. See G. Æ. p. 119, No. 626.

297. See Nos. 24, 57, 144, etc.

298, commonly taken for ⲛⲉⲛ, noster, refers to the root פנה (pana), adspicere ; hence under consideration, because the T. S. translates it by τοῦτο, in l. xxxvi., and many other places.

299 represents the act of sitting, ϩⲉⲙⲥⲓ, related with ⲙⲁⲥ, sedimentum, and therefore it expresses *ms*, e.g. on the London bilingual coffin (Pl. xxxii. 448, *b*) and on the R. S. vii. viii., where it is translated ξόανον, image, referring to the root ⲙⲁϣ, cædere, מסע (masa), cædere lapides, the latter erroneously referred by Gesenius to the root נסע (nasa), evellit. This is the root of *mason*, related with מחא (macha), μάχη. The added scourge, called ⲕⲗⲁⲙ, r. כלף. כלב, כרב (*klp*), gives imago cæsa, image. G., not knowing what to do with sitting figure, omitted to mark its place by ....

300. See Pl. i. Nos. *a* 1, *a* 5. According to Ch. it signifies "Chnum," which, however, is no Egyptian word at all.

301. See Nos. 142, 59, 19, 60, 47, 36.

302. See No. 60. G. imagined *km km* to signify "the double land" instead of the army.

303. See Nos. 10, 64, 43. G. translates "Har"; but, alas, the Egyptians never used ideologic figures, and the sparrow-hawk expressed *kr* and not "*har*."

304 represents thrashed straw, ⲧⲟϩ, a. ⲧⲟϫ, related with דיש, a. דוך (duk), triturare (T.B. Pl. xli. B), and hence it expresses very often *tk*, e.g. ⲧⲁϣ, a. ⲧⲁⲕ, provincia, and ⲧⲱⲕ, textura. Germ. Tuch. G. discovered these two figures to signify "horizon"—of course, enigmatically — instead of the northern and southern countries.

305. See 295. The letters *kr*, contained in the name of the bowl, obviously refer to ϭⲣⲟ, vincere, owing to the following word. G. takes it again for "lord."

306. See 204. The letters *kr* furnish צר (kar), the Coptic ϭⲟⲣϭ, i.e. ϭⲉⲣϭⲟⲣ, persequi, and the added figure of a man forms the personal substantive inimicus, hostis. The anti-emperor to Vespasian, as is known, was Sabinus, who was defeated soon after the arrival of the former in Italy. Hence it is evident that the Pompeian Tablet must have been written in the first years of Vespasian, 72 or 73 A.C. G. translates our group "all things," and it is news that "all things" belonged to the class of human beings.

307. Josephus testifies that Ὑκσος, Manetho's shepherds, signifies both reges pastores and servi pastores. Indeed ⲃⲱⲕ means

servus, but its notion "king" is lost in the Coptic, yet preserved in the Hebrew פחה (pechah), præfectus. Further, since many animals get different names (G. Æ. p. 9, 16), we notice the ram to signify not only ⲁⲓⲗ, איל (el), but also ⲃⲱⲕ, although this word is wanting in the Coptic. Comp. ⲃⲱⲕ, præire. It is certain, however, that the ram or sheep expressed the letter *bk*, *pk* (G. Æ. p. 59, 231, *b*), e.g. in the name of the Decanus Abik-an, and other words. See T. B. 9, 2, and its different copies; Pl. xxxii 449, *b*. The respective name ⲃⲱⲕ, besides, is the Germ. Bock, Schaf-bock, our buck, Sp. boque, It. becco, Armen. bouch, Ethiop. bahak, etc. In short, its present figure signifies Josephus's ⲃⲱⲕ, princeps. G., on the contrary, recommends the signification "spirit," probably according to Ch's ideologic dictionary in his hands.

308, commonly in erect position, represents a flower—campanula, ⲭⲁⲣⲓⲛ-ⲓⲟⲛ, Germ. Glocke, our chalice, clock, bell-flower, κάλυξ-ς, מִגְרָק (migraq), crater, which frequently expresses Evergeta, beneficence, luck, and the like. Accordingly this campanula must express the letters *klk*, and, indeed, the Tanis-stone and a great many demotic papyri, mentioning Evergeta, express him by the letters *klk*. See Pl. xxxii. 450, *b*. The first demotic letter is the abbreviated image of the scorpion ϭⲗⲏ, accompanied by the diacritical signs, hill and boundary-stone, indicating the syllabic pronunciation of ϭⲗⲏ (G. Æ. p. 11, 22; Pl. xxxi. 435, *a*). The letters *kl* together with the following *k* forms the word *klk*, Germ. Glueck, the corrupted luck, the Coptic ϩⲗⲟϫ, a. ϧⲗⲟϫ, γλυκύ—properly, to make sweet, happy, to benefit. G., without being able to spell the figure, brought out by mere guessing its signification to be "beneficent (spirit)."

309. The owl ⲙⲟⲩⲗⲁϫ containing the letters *mlk*, it expresses not only *melek*, king, but also ⲙⲟⲩⲗⲕ, propago. G. took it for ⲙ̀, of, τοῦ.

310–12. See 238, 239, 240.

313. The figure of a harrow, ⲁⲙⲛ, (ligo), expressess sometimes *a*, sometimes *m*, in the name of the Decanus *Tμουι* and other words (T. B. 30, 4, 68, 3, etc.) See Pl. xxxii. 451, *b*. Comp. G. Æ. 9. 17. Accordingly the group is to be spelled *tam*, and to be referred to דמה (dama), image, related with ⲧⲱⲙⲓ, conveniens. G. obtained the proper name "Tum," a new Egyptian deity.

314 figures the well-known Amun, i.e. אמון (amon), opifex mundi, with his insignia ⲛⲏⲃ (lord) and ϭⲣⲏⲙ (sceptrum). This figure, in G.'s eyes an ideologic sign, κυριολογεῖ δια μίμησιν, syllabically and not symbolically. G. takes the figure symbolically for Tum.

315, representing the nose, גב (gab), preserved in ϭⲃ-ϣⲁ (naris), but shamefully transformed into a calf's head ⲁϭⲟⲗ by B., expressed with the following *t* the word *kpt*, caput; ϩⲟⲛⲧ, princeps.

316. This group contains the figures of an ear, אב (ab), אבב. Syr. הבב (habeb), arista, and the handle *ant* (G. Æ. p. 116, 606), called ⲁⲛⲑ-ⲛⲣ, r. אנד (anad). Hence we have the word ϩⲟⲛⲧ, which, like the abbreviated כהן (kohen), signifies not only priest, but also princeps. The handle expresses very often the word ⲛⲟⲩⲧⲉ, god; ⲉⲛⲉ, lapis; ⲁⲛⲁ, magnus; e.g. T. S. v. 15, xxix. xxvii.; R. S. viii. 8; see Pl. xxxii. 448, 449. Accordingly our group denotes ϩⲟⲛⲧ, capital.

317. The word ⲃⲁⲕⲓ added to ϩⲟⲛⲧ forms the notion "capital city," which is Rome; and hence ϩⲟⲩⲛⲧ (caput) ϩⲟⲛⲧ ⲃⲁⲕⲓ furnish "poliuchus, or warden, of Rome." That is to say, every city of ancient times had its own tutelar god, πολίουχος, and that of Rome was Jupiter Capitolinus, identified with Vespasian. G., of course, could not translate these words.

318. See 142. G. translates "king" instead of regent.

319. This figure of a man is the contrary of 321, and hence it belongs to the root ⲁϣ, exaltare, the people of rank, nobility.

320 frequently expresses our *and*, Germ. *und*, lost in the Coptic. See T. S. ix.; I. R. xiii. 26, etc. This and the following words were inexplicable to G.

321. See Pl. xxii. 307, where the same figure expressed king, because ⲃⲱⲕ, as we have seen, involved both *rex* and *servus*.

322. איל (el), as we have seen (Pl. i. *a*), princeps. All the following words were inexplicable to G.

323. The lion's claw, being called ϫⲁⲙⲏ, expresses different words containing the same consonants. G. Æ. 61, 249. Comp. 278 in the premises. This passage reciting the glory of God, it is evident that ϫⲟⲙ, exercitus, refers to the heavenly hosts, the starry heavens.

324. See 14, 18, 41. The figure called ⲟⲩⲟⲟⲩⲉ gives ⲟⲩⲟⲩ, princeps, etc.

325. Since ϫⲟⲙ (323) points to the heavenly hosts, we are bound to refer the following groups to the planets and signs of the Zodiac. Indeed the astronomical inscription explained in these Transac., vol. iv. Pl. ii. 1-62, calls the planets *El*, and the *elim* and *elilim* in the Old Testament signify the pagan gods, the planets.

326. See 320.

327. The signs of the Zodiac being called "the houses of the planets," and termed by the Arabians and pagan Hebrews *magaloth* and *magaroth*, hospitia, diversoria, r. גור (gur), ϫⲁⲗ, hospitium, we have to translate the elated arms (χαίρω, ϣⲁⲓⲣⲓ) by ϫⲁⲗ, hospitia, i.e. the signs of the Zodiac.

328. The phallus, which expresses *t* in Trajanus, ⲙⲁⲧⲉ (T. S. xxiv.), but synonymically ⲙⲁⲥ and ϫⲡⲟⲧ, genitus, filius (R. H. Pl. x.), was called ⲧⲟⲕ, aculeus, pugio; wherefore it expresses very often *tk* (T. S. xxiii.; R. S. vii. 19.) See Pl. xxxii. 449, *b*. According to Ch. and G., the phallus signifies "generated" and "generation" instead of planter.

329, *spt*, owing to the name of the door-bar ⲥⲃⲉ (G. Æ. 87, 434), figures the word ⲥⲁⲛⲧ, electus, præstantior, honoratio, related with כבד (kabet), præstans, honoratus.

330. See 329.

331. See 167; for ⲃⲟⲕ signifies also servus. G. takes it, copulated with the following, for "kingdom."

332, very often confounded with the kerchief in B.'s and other hieroglyphic copies (Pl. iv. No. 30), represents a thread. r. חול (chul), contorquere, called ⲕⲉⲗ, related with ϩⲱⲗⲕ, implexum opus, implicatio; signifies *kl* in ⲡⲓⲗⲁⲕϩ, Philæ, i e. ϩⲏⲓ (domus) ϩⲟⲗⲕ (textricis), (Pl. xxxii. 452, *a*), and replaces the falling man, ⲥⲁⲣⲓ, corrupted ϣⲁⲣⲓ, the Hebrew נהר (gahar). T. S. viii. xxx. Hence we obtain the word גור (gur), comprimere, or ϫⲟⲣ, ⲥⲣⲟ, superare. This thread is sometimes replaced by the synonyme ϩⲱⲥ (412, *b*).

333. The nose גב (gab) gives קוה (qava), insidiatus est, the corrupted ⲥⲱⲛ, rebellis. G. again omits hieroglyphs without marking them by .... He translates No. 333 by "kingdom."

334, 335, ⲛ ⲃⲱⲕ—ךוֹ. of the subjects, servants. B. has shamefully changed the plural into the dual, and G. brings out "of the lands," of which no trace is to be seen.

336, ϩⲁⲙ ⲥⲣⲏⲛⲓ, the man of the sceptre. See 412. G., not knowing the Egyptian syntax, collocates the genitive before the nominative.

337. See 38. G. Æ. 65, 275. G. translates "(causing) his son," the name of the gander ⲕⲉⲛ, and its signification ⲕⲏⲛ (genitor), being forgotten. G. Æ. 65, 275, *b*.

338. See 164. The darling of the Creator is Vespasian. G. correctly translates "beloved," without being able to spell the group.

339, 340. See 301. G. brings out "the king of both lands," and not the lord of the host.

341. The curved neck of this bird shows that it differs from the gander ⲕⲉⲛ and the goose ⲥⲱⲟⲥ. The latter, moreover, signifies *ss*, e.g. in סוס (sus), Pegasus, and not *a*, which is the case with the bird under consideration; for in numberless places we find the arm in lieu of this bird. T. B. 1, 14, 15, 23, 17, 49, etc. It is probable that this kind of goose refers to ⲉⲗϫⲱⲟ (anser minor, anas), mentioned in Kircher's Scala Magna and by Tattam, but omitted by Peyron. This ⲉⲗ-ϫⲱⲟ consists of ϩⲉⲗ (volare, avis) and ϫⲱⲟ, properly ⲁϫⲱⲟ, as this name is alphabetically expressed in the aforesaid places of the T. B. Accordingly the letters ⲁϫⲟ give אקדה (eqdah), i.e. ἀκτίς, glory, as the renowned hymn of Pindar demonstrates.

342, spelled *kb* (333), involves the word ⲕⲃⲁ, ultio, vindicta. G. translates Nos. 341 and 342 by "he comes," probably because he took the duck for b.

343 is the Hebrew על (gal), ad supra, and not ⲉ ϩⲣⲁⲓ, as the Chs. imagined.

344, the notorious letters *pt*, giving ⲡⲓⲧⲉ, arcus, and not "the heavens."

345 represents the heavenly arch, from which the words פאה (peah), cœli plaga, ⲫⲉ, cœlum, and the names of ⲡⲓ, Πῖ, Pe, and their Phœnician, Greek, and Latin forms originated. See Pl. xxxii. 455. G. imagined it to signify, ideologically, "heaven."

346. The well-known letters *kb*, *kf*, furnish the word ϫⲱⲱⲃⲉ, transcendere, superare, and not "therein," as G. fancied.

347, representing the eye-lashes (227), ϫⲉⲛϩ, elicits the word ϫⲛⲁϩ, oppressor, and not "beholds," symbolically expressed by the eye-lashes, as poor G. guessed.

348, the figure of a wine-press, or rather of the screw with the box called ϩⲱⲙⲓ, expresses *hm* in numerous places. G. Æ. 112, 595; T. S. i. 9, xvi. 9., where it signifies ϩⲁⲙ, homo. G. connects the screw with the following *ms*, and brings out "therein."

349, ⲙⲓϣⲓ, ⲙⲉϣ, pugnare, expressed by the familiar letters *ms*.

350. See 58, 231, 336. It is self-evident that this "mighty god" concerns Vespasian, and that "the man warring against" him denotes the rebel emperor Sabinus, who was defeated, and absconded during a period of nine years.

351. This figure of the reed is wanting in my copy, but represented by B. I therefore respectfully request the present Director of the *Museo Borbonico* at Naples to examine the original, and to decide the question. It is true that the papyrus-stalks are likewise preceded in Nos. 340, 302, 60, by the reed; but, connecting that *El grepi* (the mighty hero) with the following *host*, we obtain a tolerable sense. Comp. Jes. 9, 5, where אל גוים (el goyim) is "the lord of the nations"; ἄρχων ἔθνων represents a similar composition.

352. See 60, 302, 19, 36, 47. G. again improvisates, "both lands."

353. See 312. G. creates a new god, called "Tum."

354. The human head (κάβα, κεφαλή; G. Kop, Kopf; קוף, kop), followed by *t*, gives *caput*, ϩⲟⲧⲓⲧ, a. ϭⲟⲧⲓⲧ (kbt). See G. Æ. 44, 116. And hence we have the word "caput," princeps. G. suggests "in."

355 is not a picture of a hazel nut, ⲕⲁⲣⲓⲁ, but the Egyptian apron (see T. B. 125, etc.), as I learned from the late Prof. H. Wutke in Leipzic, called ϫⲉⲗ, and hence expressing the letters *kl*, *kr*, e.g. in ϭⲟⲗϥⲓ, fur (T. S.) See Pl. xxxii. 454, *a*. Accordingly our group, spelled *krb*, exhibits the word κορυφή, the corrupted ϣⲟⲣⲡ, princeps, principalis. G. holds the apron for "sanctuary," and the snake for the suffix "his."

356, the notorious letters *thp*, ⲑⲟⲧⲁⲓ, signifying porta, and then a house. Accordingly the groups 354, 355 and 356 contain the words: (the image) of the chief of the capital city. On this occasion we learn that the tutelar god of Rome, viz. Jupiter

Capitolinus, was not the planet Jupiter, or the sun, but Deus Optimus Maximus. Congruously the city of Rome was that of רום (rom), the elevated one. The following hieroglyphs surpassed Ch's system, but G. forgot to note their inexplicability.

357. This vase I refer at present to the name κhhκιϫι, related with our can, Germ. Kanne, the added κιϫι (parvus), signifying a small can. It stands very often instead of *kn*. (Pl. xxx. 454, *a*, κhh, genimen.

358–59. The axe being called ϩατηp, and the handle אנד (anad). we have the word ϩωn, rector, governor. G. Æ. 116, 606, 87, 428. G. translates, "the great god."

360–61. Since the papyrus-plant גמה (gomah) expressed *km* (G. Æ. 77, 355), and the two tamariscus branches (οει) not only *i* but also *s* (G. Æ. 77, 362), the word κΜε, the Hebrew חום (chum), "obscuritas" comes out. Adding ϭοϯαι, house (see 356), we obtain "the house of obscurity," i.e. the invisible residence of the great god. Comp. the similar enunciation in these Transactions, vol. iv. p. 63, 22. G. happened to bring out "who approaches," of which no jot is visible. The following *thp* is in his eyes a shrine. 362. See 162, 301.

363. See Pl. ii. 3. In both cases the diacritical is added. G. ingeniously interprets the reed and the bee by "Lower and Upper Egypt."

364–65. The name of the rabbit being oun-iculus, Germ. kaninchen, cony, the words κhh, genitor, noϥpi, bonus, come out. G. Æ. 68, 262. And this is the figure on the head of our Tablet, El, Elohim.

366, the readily recognizable syllable *mn*, impertivit, which G. translates "may remain."

367 is *mn* (G. Æ. 80, 381, *b*,)and refers to the root מנה (mana), partiri, portio.

368. As the open mouth signifies crying, קרא (qara), cla-mare, etc., it likewise expresses *kr*, *kl*. See No. 147; G. Æ. 48, 143. G., on the contrary, owing to his short memory, copulates the mouth with the following *n* in order to make out the word "name."

369. By want of proper care B. neglected to copy the hill and the second image of the weaver; wherefore G. created "names," the word "your" being authoritatively inserted.

370. See 277. G. Æ. 44, 117. G. discovers the word "upon" expressed by the head.

371. See 33. The context proves that this figure (*tk*) signifies not only provincia (ⲧⲟϣ, תקע. thako), but also a woven stuff, Ger. Tuch. We find it, moreover, very often among textures and other sacrificial paraphernalia. T. B. 17, 59, 72, 8. According to G., this figure, signifying *t* in Darius, etc., symbolized "earth" (G. Æ. 84, 407.)

372. This group, misrepresented by B., expresses by the well known letters *kr* the word כלי (kli). ϫⲉⲗ, ϫⲟⲗϩ, ϭⲗ, vestis. Nevertheless G. translates "in"; and the following three hieroglyphs he took for "favor," or he omitted to mark by .... the impossibility of understanding them.

373, representing a chain, ϩⲓⲧⲉ, a. ⲕⲓⲧⲉ, G. Kette (G. Æ. 108, 568), the Hebrew צעדה (katah), cat-ena; accordingly signifying ϩⲟⲓⲧⲉ, vestis. G. probably transferred it to his "favor."

374. The notorious chalice ⲁⲛⲟⲧ, ⲁⲫⲟⲧ, a. ϩⲁⲛⲟⲧ, by which the Egyptians expressed the words ϩⲟⲩⲓⲧ, Haupt, primus (I. R. xi. 653); ⲛⲟⲧϩ, sculpere (I. R. iv. 24); ϩⲟⲛⲧ, creare (see No. 381), and here ⲉⲫⲟⲩⲧ, אפוד (epod). G. Æ. 96, 498.

375, ϲⲉⲛⲓⲙ, linteus. G. Æ. 102, 537; see Nos. 5, 84, 172, 210, 244. The sign of plurality belongs to all the preceding substantives.

376, ⲛ. אל (el). ϭⲡⲛⲙ, for the almighty God. G. translates "Chnum," but no such god has ever existed.

377–78: the lord of the hosts. See Nos. 301, 59. G. translates: "the king of both lands."

379 gives the word על (gal), præterea, owing to the name of the skull ⲕⲁⲣⲁ. G. brings out "while," because he imagined the cranium to signify, *hi*, in.

380. The values of these hieroglyphs being known (G. Æ. 73, 328, 96, 498), the group expresses ϭⲟⲧⲛ, superare, vincere. G. fancied the first two letters to signify "ye say"; but "ye" is unauthorizedly inserted by G.

381 furnishes ⲟⲩⲟⲧ, potentia, because the pullet expressed *hp*, and not, as Ch. imagined, *o*. G. Æ. 71, 312. G., without caring for the pronunciation of the hieroglyphs, translates "may."

382, the notorious ⲕⲟⲩⲣⲟ (G. Æ. 68, 301, *b*) furnishes the name Cabiri, the planetary gods. For the seven Cabiri of the ancient

Egyptians, i.e. the mighty (כביר, kabir), were the seven planets, as has been abundantly demonstrated in the author's Astronomia Æg., and the mythological monument explained in these Transactions, vol. iv. p. 55, has brought to light that the seven planets were likewise symbolized by the sparrow-hawk. G. holds the latter for an ideologic sign of "god."

383. It is to be remembered that the ancients worshipped three classes of deities, viz., the 7 planets, the 12 signs of the Zodiac, and the 36 principal constellations near the Zodiac called Decani, because each of them presided over ten degrees of the celestial globe. Now the 12 signs of the Zodiac were termed פנים (panim), ὄψεις, facies, πρόσωπα, perhaps for the reason that they were the houses of the planets, and, so to speak, faced the natures of their presidents. Thus, e.g., the old Phœnician historian Sanchuniathon reports that Taautos (the wise man), who survived the deluge, invented the postdiluvian alphabet of 25 letters, the same which the Greeks, Egyptians, Indians, Scythians, etc., used; established the alphabet while imitating the ὄψεις θεῶν. At the end of the deluge, says Sanchuniathon (Euseb. Pr. Ev. i. 10), *Θεὸς Τάαυτος, μιμησάμενος τὸν οὐρανὸν, τῶν θεῶν ὄψεις, Κρόνου τε καὶ Δαγῶνος καὶ τῶν λοιπῶν, διετύπωσεν τοὺς ἱεροὺς τῶν στοιχείων χαρακτῆρας.* Here it is apparent that the signs of the Zodiac were called *facies deorum.* The interpretation of this passage (Seebode, Jahn und Klotz's Neue Jahrbucher für Philologie, 1834, ii. Sup. p. 504) has been put beyond question by computations, according to which our alphabet was in fact determined at the end of the deluge. See the writer's "Unser Alphabet, ein Abbild des Thierkreises," etc., Leipzig, 1834; "Unumstaesslicher Beweiss," etc., Leipzic, 1839. These results are at present unexpectedly ratified by the Pompeian Tablet. For the group 383, the eye, called ὄψεις, r. ὄπτω, corrupted ϩⲏⲛⲏⲉ, a. ϩⲏⲛⲧⲉ, calls the signs of the Zodiac ὄψεις, the second class of ancient deities. G., following Ch's wonderful theory, discovers the mimetic symbol of the "eyes," and thus the nonsense emerges that the Creator of the world was stronger than the "eyes."—Comp. T. B. 71, 11, 17, 25, 165, 6, etc.

384. See 348; G. Æ. 113, 595. The Egyptian priest Chæremon (Porphyr. Ep. ad Anebon. in Jamblich. Myst. Æg.

p. 7) certifies that the 36 Decani belonged to the deities (non alios ponunt deos—præter vulgo dictos planetas et Zodiaci signa—et sectiones Decanorum). Even the Hindoos and Parsees acknowledged the 36 Decani, and represented them by a figure with 36 heads. Vide J. Scaliger in Manil. p. 336. Besides, the name of the Decani ϩⲛⲙⲓ, gubernatores, fits their astrological power. G. brings out "who are," but, unfortunately, the three boundary-stones never signify "who are," but plurality.

385–87. See Nos. 270, 238. G. again makes out "Suten-senen."

388. See 374. G. again produces the word "favor," and probably takes the following figure for a symbolic determinative "indicating to what class of things favor belongs."

389. Although several monoliths of this shape are to be found in European museums, and even in that of the Historic. Soc. of N. Y., their hieroglyphic pictures occur very seldom on Egyptian monuments. The figure, as it seems to me, indicates the act of waiting or reposing (ⲙⲟⲛⲉ) or veiling (ⲁⲙⲟⲛⲓ), but further researches are to be looked for.

390, κύριος, king. See 303. G., taking the following snake for ꞇ, happens to bring to light the new notion, "his reverence."

391 as well No. 395 signify the word ϩⲱⲃ (creare) by the name of the serpent ϩⲟϥ, ὄφις.

392. See Pl. i. l. G. improvisates "devoted," instead of the web. Is not that marvellous?

393 represents a mat or pouch, likewise crates, ϫⲉⲣⲁ, by which *kr* and *k* were expressed (R. S. xiv., vii. 32, viii. 24), e.g. in כל (kol), ϫⲱⲗ, Γραικός. G. Æ. 106, 556. Hence the T. S. replaces the mat in the same word by the figure of an acre, ager, Acker, ϭⲣⲉ, אכר (akar). See Pl. xxxii. 455. The subjoined hill again indicates syllabic pronunciation. See Pl. xxxi. 435. Hence we have to translate: (the creator of the web) of the universe. G , imagining the snake to signiy ꞇ, his, brings out ("devoted") "to his district."

394. See 391.

395. See 391. 396. See 36.

397. See 37. G., on the contrary, creates the country "Samtati-Tap-Necht," a land formerly totally unknown, but discovered in 1875 by Ch's Exploration Company.

398. This frequently recurring group, repeatedly translated on Hermapion's Obelisk by ἀγλαοποήσας, signifies splendor, gloria, ⲃⲟⲟⲩ, ϥⲱⲟⲩⲉ, ἀστράπτειν. For the hen (gallina cristata), called ⲃⲏϫ, expresses *b* (G. Æ. 68, 294), and the figure of the breast ⲕⲓⲃⲉ furnished *k* (G. Æ. 49, 153). Hence the same group is sometimes replaced by the synonyme ⲃⲟⲩⲃⲟⲩ, fulgor (see Pl. xxxii. 456), e.g. T. B. Pl. l. G., on the contrary, spells it "Necht," in order to form the name of the new country "Sam-Tati-Taf-Necht" of Italy, hitherto unknown.

399-400 are the well-known words ⲛ-ⲑⲏⲛⲟⲩ, vobis. G., however, abuses ⲛ, the sign of the casus, in order to make out "may," a new discovery indeed. See 407.

401. The names of the viper and the door-bar being ϫⲉⲧ and ⲉⲃⲉ (G. Æ. 79, 328, 87, 434), we obtain the word ϭⲓⲥⲓ, exaltare. G. probably translates the group, "be blessed."

402. See 400.

403, the notorious letters *tm*, forming the word ⲧⲁⲙⲓⲉ, creare. G. reads, "may repeat."

404. Since the child, called גול (gul), κόρος, expresses *kr* (Pl. ii. *f*, 116), it expresses גול (gul), ϫⲁⲗ, mansion, and not, as G. fancied, a part of the word "repeat."

405, the not unfamiliar ⲕⲉ, and which G. took for "others." Comp. T. S. xii. where it is translated by δὲ καί.

406, as we have seen (221, 236, 243, 343), called ϭⲁⲣⲁ, קרא (qara), involves the word ϭⲣⲉ, גרע (gera), which means cibus, aliment in general. According to G., it signifies "name."

407. See 399. G., having forgotten that ⲛⲧⲏⲛⲟⲩ means *vobis*, and never *vos*, brings out "your."

408. The image of a branch of a tree refers to the root עין (ek or ok), lignum, arbor, the corrupted ϣⲏⲛ, the Arabic עצא (aga), the Chaldean אע (ag), lignum, ὄζ-ος, related with the Ger. Ast, Sanscr. asthi, Lat. hasta, perhaps also with ⲟⲥⲓ, tamariscus; for which reason it expresses very often *ak*, e.g. in ⲛⲁϣⲧⲉ, a. ⲛⲁⲕⲧⲉ, (Young's Hier. Pl. 65), likewise ⲁⲟⲩⲟ, axilla, the shoulders (of Serpentarius), and stands for *ak*. Pl. xxxii. 456; T. S. xxxvi. Accordingly our group expresses *mk*, viz. מאז (meak), inde à longo tempore. G. brings out "for years," and he will be so kind as to show in what language *mk* signifies "for years."

409, finally, represents the palm-tree, ϭⲏⲧ, which, according to Horapollo (i. 3, 4) signifies both the year and the month ⲁϭⲟⲧ, to wit, because the Egyptians, as it is known, frequently called, in their chronological reports, the month a year (see Ideler's Chronology), owing to the root of ⲁϭⲟⲧ, i.e. עבט (abat), mutavit. See G. Æ. 75, 342. Even the name of the year שנה (shanah) involves the same idea *mutavit*, because of the root שנה (shanah), mutavit, iteravit, revolivt. The Chs. were so foolish as to maintain that the palm-tree expressed "runapat," the year, and the crescent "ⲁϭⲟⲧ," month. However, this absurdity proceeded from some manuscripts (T. B. 31, 7; 34, 1; 43, 3, etc.) which put *rnp* before the palm-tree, whilst the latter simply expresses the word "circulus" (anni). Moreover, the crescent never expresses *abot*, but *mn*, μήν, and Menes. In short, the palm-tree expresses *bt* and *b*, e.g. in ⲁϭⲏⲧ, house (H. O. South ii. 23), *b* in ⲁⲧⲟⲟⲩⲓ, γενέθλια (T. S. iii.), בנת (beneth), Virgo, ⲧⲁⲡⲉ, Thebæ, etc.; accordingly here the word ⲁϭⲟⲧ, year.

This is my grammatical and philological commentary to the so long sealed Tablet of Pompeium, and I hope that none of its 409 words have been misunderstood. I know the difficulty of correctly translating entire hieroglyphic texts since 1826; it is the same which affects the Hebrew literature, from the fact that the same consonantal combinations express very different notions. E.g. בר (br) admits at least nine different versions; from the letters *ad*, *ada*, *adah*, it is possible to bring out still more significations. Suppose that a Hebrew copy of the Old Testament, written without the Masoretic vowels, came into our hands, how difficult it would be to translate these old writings, no version being known. The same is the case with the old Egyptian literature. And yet the old Septuagint interpreters have demonstrated the possibility of translating the Hebrew Testament under the same circumstances. It is, therefore, possible to revive the whole of the ancient Egyptian literature by means of sane principles, which is, however, impracticable by the instrumentality of Ch's theory, as the following specifications will make clearer.

PARALLELS OF THE SINGLE GROUPS.

Since the death of Prof. M. Uhleman in Göttingen, and Prof. H. Wultke in Leipzig, I presume there are not two persons in existence who know the nature of Champollion's and the author's hieroglyphic systems. It will be instructive for everyone, finally, to see with his own eyes the totally different results of the two theories.

	THE WRITER.	GOODWIN.
1.	The chief	The Prince,
2.	of power,	President,
3.	the king	Keeper
4.	of the heavens,	of the seal,
5.	the creator	Companion
6.	of the cloak	of the
7.	verdant	javelin,
8.	of the earth,	?
9.	the builder	Prophet
10.	of power	of Har,
11.	all	Lord of
12.	hidden	Heb-
13.	in the world,	nu,
14.	the builder	Prophet
15.	of the deities,	of the gods
16.	the regent	of
17.	of the country,	Sah,
18.	the builder	Prophet of
19.	of all nations,	Samtati
20.	the weaver	of
21.	of the hotels	A-
22.	numberless	hehu
23.	on the earth,	the country.
24.	the stitcher	Spiritual supe-
25.	of the constellations	of [rior
26.	on the heaven,	the Un,
27.	delighting	chief-
28.	everyone;	man
29.	the weaver	of the Priests
30.	of the vesture,	of
31.	the cloth	Sechet
32.	of the	in
33.	plantation	the land
34.	delightful,	?
35.	on which	whole,
36.	all nations	Samtati-
37.	originated;	Taf-Necht,
38.	the progenitor	son of
39.	of the conqueror	the master
40.	of the hideous,	of the house,
41.	the builder	Prophet of
42.	of the glory of the	Amun-
43.	illustrious lord,	Ra
44.	the manager	?
45.	of the garden	Shat-
46.	terrestrial	?
47.	of all nations,	tat-Samta-
48.	namely, of	ti-
49	the governor,	Afanch,
50.	together with	born of
51.	the manageress,	the lady
52.	the governess,	Anchta;
53.	his consort,	?
54.	who says:	saith:
55.	I am	O!
56.	the lord	Lord
57.	of the deities,	of Gods,
58.	the lord El,	Chnum,
59.	the lord	King of the
60.	of the hosts,	double land,
61.	the king of	Ruler of the
62.	the countries	districts,
63.	the artist of the	who risest
64.	illustrious regent,	to enlighten
65.	together with	the earth
66.	his sons;	?
67.	his right eye,	whose right eye
68.	that is	is
69.	the majesty of the	the Disk
70.	sun;	Solar,
71.	his left eye,	whose left eye
72.	that is	is the
73.	the splendor	?
74.	of the moon;	Moon,
75.	his face,	whose spirit

	THE WRITER.	GOODWIN.		THE WRITER.	GOODWIN.
76.	that is	is	122.	many joys,	rejoiced,
77.	the vault	Shu from	123.	pleasures	there was
78.	of splendor,	nostrils	124.	many	exultation
79.	the tabernacle	his	125.	in the house,	in every house
80.	of luminaries	issues	126.	and	on
81.	being fixed	the wind	127.	outside of	seeing
82.	on its bosom.	of the North	128.	the mansion.	what hast
83.	Again,	to	129.	I made	done
84.	I created	en-	130.	the virtue	thou
85.	the men	liven	131.	of the man	for me
86.	other	creatures	132.	to search	to
87.	all,	all:	133.	to benefit	advantage
88.	the poor man	I am	134.	even	?
89.	and	thy	135.	his own ones	their
90.	the rich men,	Prophet,	136.	by many joys	many
91.	and	my	137.	in contemplating	and many
92.	the souls	heart is			
93.	in the	according	138.	the building	times.
94.	water,	to ways	139.	grand;	Thou didst
95.	and	thy,	140.	in seeing	give me
96.	sorts	(I) have been	141.	the pride of the	entrance
97.	all of	I	142.	imperial house	to the palace;
98.	the souls	faithful	143.	the court	the heart
99.	of the field	unto	144.	of the god	of the god
100.	and	thee,	145.	kind,	good
101.	the woods;	not	146.	high-minded	was pleased
102.	I made	have	147.	in the	?
103.	the shape	made	148.	heart	?
104	of the man,	I	149.	to	with
105.	the filament	a dwelling,	150.	everybody,	my
106.	of the muscles,	except	151.	the image	words.
107.	the cuticle	dwelling	152.	of the great Lord	Grant
108.	of the skin	thy,			
109.	together	not	153.	for thy sake,	thou didst
110.	with the hair	turned away	154.	who made	to me
111.	of the man,	I have	155.	again	the oil
112.	likewise	from doing	156.	a multitude of joys	of gladness
113.	the beard.	....			
114.	I made	....	157.	by making	in that didst
115.	the egg	....	158.	for thy behalf	thou
116.	of the child	....	159.	this chamber	spare
117.	within	....	160.	the domicile	?
118.	the man.	....	161.	of the Creator	Egypt.
119.	I wove	Everyone's	162.	of the earth,	?
120.	the heart	heart	163.	who planted	Thou didst put
121.	for	?	164.	loving	kindness

	THE WRITER.	GOODWIN.
165.	in	into
166.	the heart	the heart
167.	of the regent	of the ruler
168.	towards	of
169.	the generation	Asia,
170.	of the circuit	?
171.	of the earth.	?
172.	I created	?
173.	the cloth	?
174.	of the gods,	councillors
175.	the court	his
176.	of splendor	did honor
177.	for the men,	to me,
178.	delighting	he gave
179.	everyone.	me
180.	I joined	the post
181.	the vesture,	of chief
182.	I wove	of the Priests
183.	the garment	of Sechet
184.	of Isis'	in Es-
185.	house	?
186.	the grain	se-
187.	of the mother	nem
188.	of all.	Chief
189.	I wove	of the Priests
190.	the garment of	of Sechet
191.	the southern land	on the
192.	and the northern land.	double land,
193.	I spun	Head
194.	pudendum,	of the Park.
195.	the limb of man,	Me
196.	I devised	defend
197.	for thy sake	thou didst
198.	the limb	?
199.	muliebre	in the battle
200.	for populating	of the
201.	the regions	Greeks
202.	all of	?
203.	the earth,	?
204.	conformably	when
205.	to the Creator	smite
206.	great	thou didst
207.	of the nations	Asia
208.	in the circuit	?
209.	of the world.	?
210.	I made	?
211.	the valleys,	?
212.	the glens	killed
213.	of them,	they
214.	the many rivers	many
215.	with my arms	of companions
216.	my own ones.	my.
217.	Moreover	Not
218.	I worked	he raised
219.	the face,	hand
220.	worked	his
221.	the voice	against
222.	of man,	me,
223.	the two eyes,	eyes
224.	the limbs	were
225.	of the two arms,	dull.
226.	the eyelids,	Afterwards
227.	the eyelashes,	?
228.	the pupil,	?
229.	the nose,	?
230.	the ears,	?
231.	I thy great God;	Thy Majesty
232.	too	?
233.	I formed	said
234.	the man	to me:
235.	especially	Go
236.	the walking	thou
237.	according	to
238.	to the Lord	Suten-
239.	autocrat	senen
240.	of the world.	?
241.	I devised	Be thou
242.	the socket,	diligent
243.	the leg,	?
244.	the shin-bone,	?
245.	the arm,	?
246.	the hand,	?
247.	the feet,	to traverse
248.	the palms,	the regions

	THE WRITER.	GOODWIN.
249.	the flesh	alone
250.	of the arm,	?
251.	the flesh	?
252.	of the elbow;	by thyself.
253.	woven	Embarked
254.	I have	I for
255.	the vessel	Uat-
256.	for effusing	Ur
257.	water;	?
258.	further,	Not
259.	I combined	I feared
260.	the girdle	?
261.	of thy gut.	difficulty.
262.	Again,	Not
263.	I stitched	I disobeyed
264.	the scrotum,	?
265.	the testiculi	?
266.	on	?
267.	thy body,	thy command,
268.	the comb	reached
269.	of the feet,	I
270.	I thy Lord,	Suten-
271.	autocrat	senen
272.	of the world.	?
273.	Again,	Not
274.	I planted	was hurt
275.	the hairs	a hair
276.	on the skull.	of
277.	I contrived	my
278.	the kettle	head.
279.	of the brain,	The beginning
280.	the canal	was observed
281.	of respiration.	in accordance
282.	I made	with that
283.	the palate,	commanded
284.	the teeth,	thou hadst;
285.	the throat,	in the end,
286.	the voice	thou gavest me
287.	for uttering	a long
288.	words,	space
289.	songs	of repose
290.	delightful	?
291.	for comforting	?
292.	the heart.	?
293.	I am	O!

	THE WRITER.	GOODWIN.
294.	the emanator	ye priests,
295.	of the Lord,	all
296.	the servant	who serve
297.	of god	this
298.	that,	god,
299.	the image	great
300.	of the mighty El,	Chnum,
301.	The lord	king
302.	of the host,	of the double land,
303.	the illustrious king	Har of
304.	of both hemispheres,	the horizons,
305.	the conqueror	Lord of
306.	of the enemy,	all things,
307.	the prince	the spirit
308.	beneficent,	beneficent,
309.	the germ	in
310.	of the Lord	Suten-
311.	autocrat	senen,
312.	of the world,	?
313.	the likeness	Tum
314.	of the Creator,	first
315.	the tutelar god	in
316.	of the capital	....
317.	city,	....
318.	the regent	king of
319.	of the nobility	....
320.	and of	....
321.	the vulgar,	....
322.	the Lord	....
323.	of the hosts,	....
324.	the Lord	....
325.	of the planets	....
326.	and	....
327.	the signs,	....
328.	the planter	....
329.	of the honored,	....
330.	the planter	generations
331.	of the servants,	the kingdom
332.	the crusher	for
333.	of the rebellion	the ruler
334.	of the	of the

	THE WRITER.	GOODWIN.
335.	subjects	lands
336.	of the king,	?
337.	the progenitor	son
338.	of his darling,	beloved his
339.	the comman-der	to be king
340.	of the army,	of both lands
341.	whose glory	who
342.	of vengeance	comes
343.	to the	to the
344.	ark	heavens
345.	of heaven	?
346.	extends,	and
347.	the suppressor	behold
348.	of the man	therein
349.	attacking	?
350.	the mighty god	Chnum
351.	[the lord]	king
352.	of the host,	of both lands
353.	the likeness	Tum
354.	of the chief	in
355.	of the capital	sanctuary his
356.	dwelling,	?
357.	the germ	?
358.	of the	?
359.	regent	the great god
360.	in the dark	who approach-
361.	of dwelling,	the shrine [es
362.	the Lord	of the king
363.	King,	of Lower and Upper Egypt,
364.	the progenitor	Un-
365.	good.	nofer.
366.	Offer	May
367.	a share	remain
368.	everyone	name
369.	of you,	your
370.	weave	upon
371.	robes,	earth
372.	raiment,	?
373.	garments,	?
374.	mantles	?
375.	of flax	in favor
376.	for the great god,	with Chnum
377.	the Lord of	king
378.	the hosts,	of both lands,
379.	and who	while
380.	surpasses	ye say,
381.	the power of	May
382.	the Cabiri,	the gods,
383.	the zodiacal gods,	the eyes
384.	the Decani,	who are in
385.	the Lord	Suten-
386.	autocrat	senen
387.	of the world,	?
388.	the creator	?
389.	glorious	be favorable
390.	of the king,	to reverence
391.	the author	his,
392.	of the web	the devoted
393.	of the	to
394.	universe,	district
395.	the author of	his,
396.	all nations,	Samtati-
397.	who acquired	Taf-Necht.
398.	glory	May be blessed
399.	for	?
400.	yourselves,	ye
401.	who exalted	?
402.	you,	yourselves.
403.	who prepared	May
404.	a mansion	others
405.	and	repeat
406.	aliment	names
407.	for you	your
408.	since many	for years
409.	years.	and years.

Such are the fruits, since 1824, of Ch's world-renowned hieroglyphic system. It will be conceded that since the invention of typography no greater absurdity has been printed on our globe. It is true, our Chst. has more or less correctly translated a few hieroglyphs by guessing, but science wants no guess-work, and, besides, many such hieroglyphic figures express very different words in other places. The axe, e.g., does not always signify "god," as the Chts. imagined, but also *h;* the heart signifies not only "heart," but also "soul," and so on.

The question will be asked: how came it to pass that, during a hieroglyphic text logically? Answer: because Ch. knew not that period of fifty-six years, no Cht. was able to translate any entire the Egyptian literature originated from the primitive Alphabet, and not from an original ideologic writing; that the same literature was, in general, a syllabic one, as was discovered in 1826; and, especially, that each of the 630 hieroglyphs signified the two or three consonants contained in the name of the figure, as was discovered in 1844; that, moreover, the language of the ancient Egyptians was a Hebrew dialect, and not the modern Coptic. All these particulars of the writer's theory are now confirmed by the Pompeian Tablet, as the sequent catalogues will evince.

SYLLABIC HIEROGLYPHS IN THE PREMISES.

The following hieroglyphs are enumerated according to their natural series established in my Grammatica Ægyptiaca. To make the list more complete, a few examples are added taken from our bilingual monuments.

I.—*Heavenly Objects.*

Figures.	Names.	Values.	Words and References
Heaven	ϕⲏ	ph	ⲛⲧⲉ ϕⲏ. 26, 345.
Star	ⲥⲓⲟⲩ, כב	kb	כבב 176.
Sun	kur	kr	ⲭⲣⲟϯ, 66; ⲕⲣⲟ, 127: ϫⲁⲣⲁ, 288; *κύριος*, 152, 43, 64, 422, 303; *κυρία*, i. *d;* σⲉⲣⲉ, 303, 43; ⲭⲣⲟ, T.S. *καῖρος*, 442 & pas.
Sunbeam	ⲃⲟⲩⲃⲟⲩ	bb	ⲃⲟⲩⲃⲟⲩ, 78, 426; Epiphanes, R. S. ⲓⲛⲛⲉⲩ, Pegasus, astr.
Moon	ⲙⲁⲛ	mn	*μήν*, men-sis, pass. Menes, astr.
Clouds	ⲕⲗⲟⲟⲗⲉ	kll, kl, kr	ϩⲗⲱⲓⲗⲓ, ⲉⲓⲗⲉⲗ, ⲕⲟⲩⲗⲟⲗ, ϫⲟⲗϫⲉⲗ, T. S.

II.—*Geographical Objects.*

Figures.	Names.	Values.	Words and References.
Tellus	ⲃⲁⲕⲓ	bk	ⲃⲱⲕ, ⲃⲁⲕⲓ, circuit, 46, 23, 162, 240, 272, 387; ii. *g*. 317; ⲃⲩⲕⲉ. 105, 107.

Figures.	Names.	Values.	Words and References.
Mountains	ⲕⲱⲱⲃⲉ	kb	ⲕⲁⲛ, ⲕⲛⲉⲛ, 434, 171, 203 209; ϭⲟⲛ, כף. 248.
Mount	ⲑⲟⲟⲩ	tb, tp	ⲧⲟⲩⲃⲟ, 8; ⲧⲟⲛ, 82; ⲧⲉⲃ, 415; טוב. 170, 208; ⲧⲁⲩⲟ, 263; duo, 223.
Catacomb	ϩⲱⲛ	hp, hb	ϩⲱⲃ, Petamenophis, etc.
Cave	ⲃⲏⲃ	bb	ⲃⲟⲩⲃⲟⲩ, 79, 429; R. S. viii. 29
Meadow	ⲁⲙⲟⲛⲓ	mn	מנה, share, portio, 367; ϩⲙⲉⲛⲉ, T. S.
Garden	ϫⲱⲙ	km	ϫⲟⲙ, 45; ϣⲱⲙ, T. S. & pass.
Arboretum	ϣⲏⲛ	sn	ϣⲏⲛ, 456. [T. S.
Acre	אכר	kr	Γραικός, 455; ϭⲣⲟ, I.R. ϫⲟⲣ,
Boundary-stone	ⲟⲩⲉⲧ	bt	ⲟⲩⲟⲧ, i. c; תו. 15, 62, 213, 203, 135, 335, 402, 409.
Fence	ϭⲗⲟ	kl	ϫⲱⲗⲓ, 440 R. S.
Sand	ⲁⲗ	l, r	ϩⲗⲁⲗ, ϭⲁⲗⲓⲗ, T. S. l. iii. xviii.
Sea	ⲙⲏⲣⲉ	mr	ⲙⲏⲣⲉ, mare, 94, 257; ⲙⲁϩⲣⲟ, T. S.; ⲙⲏⲣⲉ, libatio, T. S.

III.—*Human Figures not ornamented.*

Figures.	Names.	Values.	Words and References.
Man	ⲁⲛⲟⲕ, אנויש	ank	ⲁⲛⲕ, I am, 55, 293.
Child	ϣⲏⲣⲓ, עול	kr	κόρος, ii. 1, 116, 386, 404 & pas.; καιρός, 442; T.B. 87, 2; Κοίρανος, 239, 271, 311, 386, 116; ϫⲁⲗ, 404.
Vir	ⲁϣ, איש	ash	ⲁϣ, 28, 49, 88, 97, 118, 131, 147, 195, 222, 234, 219, 216, 254, 104, 111, 150.
Homo	ϩⲁⲙ	hm	ϩⲁⲙ, 306 & pass; T.B. 1. 1, etc.
Woman	ϩⲓⲙⲉ	hm	ϩⲓⲙⲉ, T. B. 15, 18, 19 & pass.
Waiting	ⲙⲟⲛⲉ	mn	ⲁⲙⲟⲩⲛ, 389; ⲁⲙⲟⲛⲓ, Sarcoph. Vien.
Joying	ϣⲁⲓⲣⲓ, χαίρω	kr	χαίρειν, 122, 136, 156, 214, 290.
Kneeling	ⲃⲉϩ	bk	ⲃⲱⲕⲓ, ⲃⲓϫ, Libra, Astron.

IV.—*Human Figures ornamented.*

The ram-headed man, ϩⲁⲙ-אל, the almighty Being, Pl. i. *a*, 231, 350, 300, 231, 376, 58.

[*Note.*—Sometimes other insignia are conjoined with this figure, e.g. the solar disk, the ostrich feather, the sceptre, forming adjectives, of which the signification will be found below.]

The man with the Uræus-snake, ϩⲁⲙ ϫⲟⲣ, king, 422.

The man with the sceptre, ϩⲁⲙ ϫⲣⲏⲙ, king, 336, 314.

The kneeling with the papyrus-stalk, ϩⲓⲙⲉ, γαμετή, consort, 53.

Phthah with the double crown, ϩⲟⲡⲧ ⲛⲉⲃ, 314.
The shouting with the ostrich feather, χαίρω-ⲙⲁϩ, 214.
Sitting with the hostage, ⲙⲏϣ, ⲕⲗⲏⲙ, σⲟⲗⲏ, statue, 299.
The thrasher, ϩⲓⲧⲉ, ht; ϩⲓⲧⲉ, to spin, 193.
The blind man, ⲃⲉⲗⲗⲉ, bl, ⲟⲩⲱⲗⲉ, בעל. 193, 436, 445.

V.—*Human Limbs from the head to the toes.*

Figures.	Names.	Values.	Words and References.
Skull	ⲕⲁⲣⲁ	kr, kl	ⲕⲟⲣⲏ, 420; ϫⲓⲣ, 228; ϫⲁⲣⲟ, 149, 117, 121; ⲕⲁⲣⲁ, 228; על, 379. 232.
Brain	ⲁⲛϫ	ank	ⲁⲛϫ, 411; אנוש. 75; ἄναξ, 40, 52, i. *a*.
Head	ⲁⲡⲉ (ⲕⲁⲡⲉ)	kp, kb	445; ⲕⲁⲃ, 277; ⲕⲏⲃ, 370.
Hair	ⲕⲁⲡ	kp, kb	ⲕⲁⲡ, קן. 110. 275; כאב. ϩⲏⲃⲓ, 431.
Tail (barba?)	ⲕⲁⲡ (Zop)	kp	Hophra, T. S. xv.
Optic	ϩⲏⲡⲉ (ὄπτω)	hpt	ϩⲟⲡⲧ, ϯ, ⲛⲧⲁϩ, 161; T. S. iv. ὄψεις (signs), 373; ϩⲟⲡⲧ (eye), 67, 71.
Eye-lashes	ϫⲉⲛϩ	knh	ϫⲉⲛϩ, 227; ϫⲛⲁϩ, 347.
Pupil	ⲁⲗⲟⲩ	ar	ⲁⲣ, 157, 129, 223; אל (with) 50.
Iris	ϫⲓⲣ	kr	ⲕⲟⲣ, 442 and passim.
Nose	נב. σⲃ-ϣⲁ	kb, kp	ⲕⲱⲃ, 424; ⲕⲁⲡ, 62; ϩⲟⲩⲓⲧ, caput, 315; ⲕⲃⲁ, 342; ϫⲱⲟⲩ, 289; ⲉⲱⲛ (ⲕⲱⲛ), 333.
Palate	ϫⲁϫ	kk	חן. T. S. xvi. xvii. xxi.; R. S. pass. ϫⲁϫ, 283: T. B. 160, 3.
Tongue	ⲗⲁⲉ (לקק)	lk	T. B. 65, 1; 2, 2; 23, 1, 2; 153, 5, 7, etc.
Mouth	ϫⲁⲣⲁ	kr, kl	קרא. 221; נור. 417; ϫⲟⲗ, כל, 368. 188; Chaldæa, 415, 416; ϫⲣⲉ, 401; σⲁⲗⲟϫ, ⲕⲉⲗϫ, 236, 243; ϫⲁⲣⲟ, 147; κορυφή, 1; על. 343.
Tooth	שן. dens	shn	ϣⲏⲛⲉ, 27, 34.
Atlas	אטר	tt	Young's Hier. Pl. 68; Dl. T. B. 155, 2; ⲧⲁⲧⲉ, T. R. x. 34.
Orgya	ϩⲛⲱⲧ	hpt	ϩⲟⲟⲩⲧ, 101; ϩⲟⲛⲧ (combine), 109; ϩⲟⲛⲧ (again), 273, 258, 217, 262.
Joying	צהר. זהר. χάρα	kr	*Κερκέρης*, 430; ϫⲁⲗ, 327 and passim.
Beating	ⲕⲟⲗϩ	kl, kr	T. S. v.; compare κολάζειν, κολάω.
Fighting	ⲙⲓϣⲉ (μάχη)	ms	ⲙⲁⲉ, 199.

Figures.	Names.	Values.	Words and References.
Arm	ⲙⲁϩⲓ	mh	ⲁⲙⲁϩⲓ, 350, 444, 225.
Club	ϩⲓⲧⲉ	ht	ϩⲓⲧⲉ, 37, 397; ⲑⲁ, *θαχέλοφις*, etc. חת. 37, 205, 397.
Weighing	דין	tn	תנה. T. S. xxxiii. xxxiv. xxxv. & pass.; tone, tonus, 286.
Hand	ⲧⲁⲁⲧ	tt	ⲧⲟⲟⲧ, 246, 443, etc.
Finger	ⲑⲉⲃ	tb	ⲑⲃⲁ, myriad, 10,000, & pass.
Breast	ⲕⲓⲃⲉ	kb, kp	ⲕⲟⲡ, Pl. ii. 1; ⲕⲱⲃ, 392, 429.
Heart	ϩⲏⲛⲧ	krt	court, 143; *καρδία*, 98, 92; cor, 292, 148, 166, 120.
Penis	ⲧⲟϭ	tk	ⲧⲏϭ, ⲧⲁϫ, genimen, R. H. Pl. x. 328, 330, 489.
Genimen	ⲕⲏⲛ	kn	ⲕⲏⲛ, 115, 428; *γύνη*, pass.
Gut	ϭⲏⲧ	kt	ϭⲉⲧ, 261 (colon).
Leg	ϭⲗⲟϫ, ϭⲗⲱⲧ	klt	ϭⲗⲟⲧⲉ, 265.
Foot	ⲡⲁⲧ	pt, pd	בד. membrum, 195; ϩⲟⲡⲧ, 63; ⲟⲩⲉⲧ, 123; ⲡⲟⲧ, 280.
Going	ⲧⲟⲟⲧⲉ	tt	דדה. incedere, 247; ⲧⲁⲧ-ⲉ, 269; ⲧⲁⲁⲧⲉ, 141; Athothis, 433.
Thumb	ϩⲏⲧ	ht	ϩⲟⲧ, 242, 442. [333.
Nail	ϩⲓⲏⲃ, ⲕⲏⲃ	kp, kb	ⲕⲱⲃ, pass.; ⲕⲱⲟⲩ, 289; ⲥⲱⲡ,

VI.—*Quadrupeds.* A. *domestic.*

Figures.	Names.	Values.	Words and References.
Horse	ⲩⲡⲉⲩ, *ἵππο-ς*	hpp	ⲩⲡⲡ, Hippone city, etc.
Cow-horn	ⲧⲁⲡ	tp, tb	ⲁⲧⲟⲟⲩⲓ, 429, 430; ⲧⲱⲡ, T. S. ⲧⲱⲃ, 106; T. S. ϩⲟⲧⲡ, 180.
Calf's-head	ⲁϭⲟⲗ	akl	ϭⲗⲡ, אגל. ϫⲱⲓⲗⲓ, pass.
Ram	ⲁⲓⲗ	al	איל. i. *a*, 322, 325.
Sheep, buck	....	bk	ⲃⲱⲕ, regent, 307; ⲃⲟⲕ, servant, 321; ⲟⲩⲱϫ, Germ. Backe, 75.
She-goat	ϭϩⲟⲉ, עז	ks	ϭⲓⲟⲉ, deus, 16.

VII.—*Quadrupeds*, B. *wild.*

Figures.	Names.	Values.	Words and References.
Lion's claw	ϫⲁⲙⲏ	km	ⲕⲏⲙⲉ, Egypt, R. S.: ϫⲱⲙ, book, T.B. pass.; קומה. T.S.; ϫⲟⲙ, power, 2; ϫⲱⲙ, host, 323; ϫⲟⲙ, kettle, 278.
Lion's tail	cauda (ϭⲏⲧ, c. ⲥⲁⲧ)	kt	ⲕⲱⲧ, pass.
Fox	ⲃⲁϣⲟⲩⲣ	bkr	*βιχῆρες*, 432; בקר. observare, 137.
Turtle	ⲉⲫⲱⲧ	opt	ⲉⲫⲟⲩⲧ, אפוד. T. B. 36, *a* : 83, 2; 161, 3, 4.

Figures.	Names.	Values.	Words and References.
Lizard	אנקה	ank	ϵⲛⲁϣϵ, T.S. viii. ix. x.; H. O. pass.; T. B. 1, 16; 2, 2, 65; 1, etc.

VIII.—*Birds and their parts.*

Figures.	Names.	Values.	Words and References.
Feather	ⲙⲁϩⲓ (ⲙⲁϭⲓ)	mk	ⲙⲁϩⲓ, 411; ⲙⲁϩⲓ, arm, 215; ⲙⲏϣ, 122, 124, 156, 136; מכ. i. *a*, 413, 414, 152, 231; ⲙⲟϫϩ, 77, etc.; ⲙⲁϣⲓ, *ἀλεθεῖα*, H.O. passim.
Nest	ⲙⲁϩ	mh	ⲙⲟϩ, luminaries, 80; T.B. 17, 16; 54. 3; 142, 7.
Vulture	ⲁⲙⲁⲧϵ	mt	ⲙⲁ(ⲧ)ⲩ, 187; ϭⲓⲛ-ⲙⲟⲩⲧ, 437; T. B. pass.; ⲙⲁⲧϵ. R. S.
Eagle	(ϩ)ⲁϭⲟⲙ	hkm, hk	*φοινίκη*, T. S. ix. 211.
Owl	ⲙⲟⲩⲗⲁϫ	mlk	מלך. pass. 431; ⲙϵⲗⲁϫ, 309.
Sparrow-hawk	ϫⲟⲗ	kr, kl	*κύριος*, ϫⲟⲣ, 382, 390, 431, 436, 418, 305.
Gander	ⲕⲏⲛ	kn	ⲕϵⲛ, 38, 337, 422; ϭⲟⲛϩ, 260.
Roasting	ϩⲟⲛⲧ, *ὄπτω*	hpt	259; T.B. 17, 89; 78, 2, 6, 9, etc.
Cock	ϵⲣϫⲱ	rk	ⲣⲁϣⲓ, G. E. 67, 286; T. B. 17, 16, 88, 38, 3, 42, 11, etc.
Hen	[ⲕⲁⲣⲁ]ⲛⲏⲛ? ϩⲓⲃⲟⲩⲓ?	bb, pp	*Πτη*-ⲃⲓⲟⲩ, *ἵππος*, Astr.
Pullet	ϩⲁⲛⲱⲧⲓ *ὕπταμαι*	hpt	חו. 22, 68, 72. 76, 83, 434.
Anas, duck	(ⲁ)ϫⲱⲑ	akth	*ἀκτίς*, glory. 341; T. B. 17, 20, 42. 49.

IX.—*Insects.*

Figures.	Names.	Values.	Words and References.
Queen-bee	מלך, melek	mlk	*μέλιτα*, 3, 363, 413.
Scarabæus	(*κάν*)-*θαρος*	tr	ⲧⲁⲣ, דור. dur, 103.
Scorpio	ϭⲗⲏ	kl	ϫⲟⲗϩ, T. S. iii. xxx. 435.

X.—*Serpents and Fishes.*

Figures.	Names.	Values.	Words and References.
Uræus	ⲁⲕⲱⲣⲓ	kr	(ⲕ)ⲟⲩⲣⲟ. Pl. i. *c*, *e*: 64, 43.
Viper	ϫⲁⲧ-ϥⲓ. טיט (tet)	kt	ϫϵⲧ, 48, 233, etc. [175.
Eared-snake	ϩⲱⲃ	hb, hf	ϩⲱⲃ, 218, 220, 391, 398; ϩⲏⲛⲓ,

XI.—*Trees, Shrubs, Plants, Flowers.*

Figures.	Names.	Values.	Words and References.
Palm	(ⲁ)ⲃⲛⲧ	bt	ⲁϥⲟⲧ. 409, 429, 456.

Figures.	Names.	Values.	Words and References.
Tamarisk	ⲟⲉⲓ	os	ⲕⲉⲙⲉ, 360; G. Æ. 77, 361.
Branch	עצר. Ast, ϭⲉⲧ	akt, ⲁⲕ	T. S. xii. xxxvi. 408. 411, 456.
Papyrus	ϫⲱⲙ, גמא	km	ⲕⲏⲙⲉ, R. S. v. 43, ϣⲏⲙ (קומה) T. S. xxxi.; ⲕⲏⲙ. 360. 192; ⲕⲙⲉ, 200.
Papyrus-stalk	ⲕⲁⲙ	km	ⲕⲏⲙⲉ, T.S. ix. etc.; ϫⲟⲙ, kettle, 255; ϫⲱⲙ, host, 378; ϫⲟⲙ, natio, 396; ϫⲱⲙ, host, 19. 36, 47, 60, 302, 352, 378; Γάμη, Pl. 1 *d*, etc.
Sedge	ⲥⲁⲣⲓ, ⲕⲁⲣⲓ	kr	(ⲕ)ⲟⲩⲣⲟ, 218, 142, 59, 270, 301, 362, 330, 377, 385, 238, 422, 423; ϭⲉⲣⲉ, 191.
Lattice	ⲃⲟⲧⲉ	bt	ϩⲟⲩⲓⲧ, 324; T. S. pass. ϩⲟⲩⲧ, 14, 18, 41; T.S. iii. pass. ⲟⲩⲟⲧ, 90; ⲟⲩⲟⲧ, ὕδατος, 230, etc.
Lotus	ϫⲁⲛⲟⲣ	kp, kb	ϩⲓⲛⲃ (ϧⲓⲛⲃ). Aries, Astr. pass., 425; זבח. T.S. ii.
Ear	אביב. habb	hb	ϩⲟⲛ, west, T. S. xvi. & pass.
Sheaf	ϩⲱⲧⲣ	htr	ⲁⲑⲩⲣ, T. S. xviii. bis; עמר, R. S. iii. 27.
Straw	ⲧⲱⲕ	tk	ⲧⲱϣ, provincia, pass.
Flower	ⲓⲁⲛ, ⲕⲁⲛ	kn	ⲕⲏⲛ, progenitor, T. S. v. 437.
Poppy	(ⲛⲉ)ⲙⲁⲛ	mn	μήνη, ⲙⲁⲛ. 74; ⲙⲟⲛⲉ, 128; Menes, Astron.
Campanula, Glocke		glk	ϩⲗⲟϫ, 308. 450, pass.

XII.—*Fruits and Seeds.*

Figures.	Names.	Values.	Words and References.
Gourd	ϭⲗⲟ	kl	ϣⲟⲗϩ, T. B. 154, 5.
Bean	(ⲕ)ⲟⲩⲣⲟ	kr	ϫⲟⲣ, 291; Bocharis, 447.
Spelt	ⲃⲱⲧⲉ,	bt	ⲟⲩⲟⲧ, זית, 40; T. B. 84, 1, 15, 25. 40. 2, 78, 4; ⲟⲩⲱⲧϩ, fundere, T. S. x. 9.
Grain	ϧⲣⲉ	kr	ϧⲣⲉ, ϩⲓⲣ, T. B. passim.

XIII.—*Architecture.*

Figures.	Names.	Values.	Words and References.
Building	ⲕⲱⲧ	kt	ⲕⲱⲧ-ⲛⲟⲩϯ, temple, R. S. pass.
Chamber	ⲕⲩⲃⲉ, קבה	kb, kp	ϩⲟⲟⲩ, ⲕⲟⲃ, T. S. xiii. xii. and pas.; ϫⲱⲱⲃⲉ, 146; ϭⲟⲟⲩ, 264.
Court	ϩⲏⲡⲓ	hp	Hof, court, 51, 44, 142 & pass.
Door-bar	ⲥⲃⲉ	sp	ϣⲟⲛ, 114, 235, 329; T. S. xv.; ⲥⲟⲩⲉⲛ, T.S. xxv.; ⲥⲛⲟⲩ, T.S. xxix.; ⲥⲟⲩⲟ, T.S. xix. 1, etc.

Figures.	Names.	Values.	Words and References.
Step	ⲙⲟⲩⲕⲓ	mk	מכ. ⲙⲏⲱ, 410 and passim.
Skiff	ϫⲟ(ⲃ)ⲓ, צוה	kb	ⲕⲏⲉⲡ, 99; ⲕⲱⲃ, 292 & passim.
Mast	ⲧⲁⲣ	tr	ⲧⲱⲣ, fixing, 81, 427; Trajanus, etc.

XIV.—*Furniture of Houses and Temples.*

Figures.	Names.	Values.	Words and References.
Throne	ϩⲓⲥⲉ, כסא	ks, hs	Hisis, Hosiris, 184 and passim.
Table	ⲡⲱϭⲉ	bk	ⲟⲩϫⲉ, T.S. vii.; ⲡⲓⲥⲉ, T.S. xx.
Axe	ϩⲁⲧⲏⲣ	htr	ϩⲧⲟⲣ, 15, 18, 57, 144, 297; ϩⲱϯ, T. S. xxxiii. etc.
Knife	ϭⲟⲣⲧⲉ	krt	ϭⲗⲟⲧ, 265, 439, 440; ϭⲉⲗⲗⲟⲧ, 212.
Handle	ענד	nt	ⲛⲟⲩⲧⲉ, 448; ϩⲟⲛⲧ, 316 & pass.
Lute	נבל	nbr, nfr, nf	ⲛⲟⲩϥⲣⲓ, 133. 145; ⲛⲓϥⲓ, 281, etc.
Rattle	ⲕⲉⲗⲕⲗ	kl, kr	ⲭⲣⲟϯ, Mum. And.; ⲕⲉⲣ, leg, Papp. memb.
Sistrum	ⲕⲗⲓⲙⲓ	klp	ⲕⲗⲓⲙⲓ, image, T.S. ix. vi. xxix. xxxi. xxxv. & pass.
Cake	ϫⲱϫ	kk	ⲕⲟⲩⲕⲉ, T. S. xxxiv. xxxv. etc.
Book	ϫⲱⲙ	km	ϫⲟⲙ, ים. multitude, 435 & pas.

XV.—*Vases, Vessels, Baskets, Measures of capacity, and the like.*

Figures.	Names.	Values.	Words and References.
Amphora	(ϩ)ⲁⲛⲟⲧ	hpt	ϩⲟⲩⲓⲧ, head, pass.; ϩⲟⲛⲧ, 388; ⲉϥⲟⲩⲧ, 374, etc.
Chalice, cup	(ϩ)ⲁϥⲟⲧ	ⲫϯ, 205;	ⲁⲛⲟⲧ, 436; ⲥⲟⲟⲩⲧ, 6, 173; Abydos, pass.
Well-bucket	ϭⲁⲗⲓⲗ	kll	ϭⲗⲓⲗ, burnt-offering, T. S. and R. S. pass.
Pot	ϣⲁϣⲟⲩ	ss	ϣⲉϣ, equal, R.S. vii. 11, etc.; T.S. pass.; ϣⲱϣ, cow; ϣⲁϣ, meal; ϣⲏϣⲓ, punishment; ϣⲉ, must; ϣⲁϣⲓ, bitter. pass.
Box	ⲕⲉⲗ-ⲱⲗ	kl	ϭⲱⲓⲗⲉ, mansion, Pl. i. *b*; Ob. Herm. pass.
Coffer	ⲕⲁⲏ	kp	ⲕⲁϩ, country, 434, etc.; ⲕⲩⲏⲏ, 159; ϭⲃ, nose, 229; ϣⲏⲛⲉ, T. S. ix.
Hamper	ϭⲗⲏⲃ, G. Korb	klb in	ϭⲟⲗⲃⲓ, 421; kr, kl, I. R. xi. 27.
Coffin	(ⲉ)ⲕⲗⲏ	kl, kr	ϫⲱⲓⲗⲉ, domicile, 21.
Basin	ϫⲟⲙ, אגם.	km	ϩⲓⲙⲉ, γάμη, G. E. 36, 30; T.S. pass.; ϩⲟⲙ, brass. T. S. 37. [etc.
Can	ⲕⲏⲓ(ⲕⲟⲩϫⲓ)	kn	ⲕⲏⲛ, 357, 454.
Inkstand	ⲙⲉⲗⲁ, ⲙⲉⲣⲁ-ⲃ	mr	ⲙⲏⲣⲉ, 415; G. E. 97, 507.

Figures.	Names.	Values.	Words and References.
Bowl	ϭⲉⲗ (ⲙⲁⲓ)	kl, kr	(ⲕ)ⲟⲩⲣⲟ, κύριος, 44, 51, 418, 295, 56; ϫⲟⲗ, כל, 87, 202 and pass.; ϫⲣⲟ. 30, 305; χώρα, 201; R.S. xiv. 19; T.S. xxxvii. 17; ϭⲗⲁ, אזל, 119.
Goblet	ⲁⲛⲟⲧ	apt	ⲁⲩⲉⲧ, בת. ϩⲱⲟⲩⲧ, 433.
Vat	בת	bt, pt	ⲃⲟⲧⲉ, 40; ⲛⲉⲧ, 68, 72 & pass.
Globular vase	ⲛⲁⲧ	nt	ⲛⲧⲉ, 427 and pass.; נדה, 88.
Effusing vase	ⲃⲉⲃⲉ	bb	ⲃⲟⲩⲃⲟⲩ, reverend, priest, pass.; ⲃⲉⲃⲉ, 294; weaver, 29, 182, 189.

XVI.—*Regalia, Apparel, etc.*

Figures.	Names.	Values.	Words and References.
Crown	ϩⲱⲛ	hn	ϩⲱⲛ, Pl. i. *a, b;* ⲛ, passim.
Peruke	ⲕⲗⲁϥⲧ (ⲕⲁⲗ ϩⲱⲟⲩⲧ)	kl, kr	עור, 108; ⲕⲉⲗ, 252.
Shawl	ⲛⲟⲩⲃⲧ	nb	ⲛⲟⲩⲃ, R. S. and T. S. passim; ⲛⲟⲃⲓ, H. O. pass.
Web	ⲁⲙⲟⲛⲓ	mn	passim. See G. Æ. 105, 554.
Kerchief	ⲕⲁⲓⲥⲓ	ks	ⲕⲁⲓⲥⲓ, 30, 181. etc.; Γραῖκος,
Apron	ϫⲉⲗ	kl, kr	κορυφή, 355, 454. [R.S.
Chain	ϩⲓⲧⲉ	ht	ϩⲟⲓⲧⲉ, 373; ϩⲟⲧ, 442, etc.
Mat	ϫⲉⲣⲁ	kr	כר־כר. χώρα, 17; ϫⲟⲗ, כל. 394.
Sceptre	ϫⲣⲏⲛⲓ	krp	412, 421; Pl. 1, *a;* 350, 300.
Pedum	ⲃⲱⲕ	bk	ⲃⲱⲕ, i. *a;* 61, 331, and passim.

XVII.—*Spinning, Knitting, Weaving.*

Figures.	Names.	Values.	Words and References.
Hatcheled flax	ⲥⲉⲛⲛⲓ	sp	ϣⲟⲛ, 282, 210, 84, 102, 172, 5, 8, and pass.; ⲥⲉⲛⲛⲓ, flax, 375; ⲉⲛⲃⲓ, 244.
Thread	ⲕⲉⲗ	kl, kr	ϭⲣⲟ, ϫⲣⲟ, 332, 452, 412.
Thread-roller	ⲕⲉⲗ	kl, kr	418, 430, and passim.
Clew	ϩⲟⲛⲧ	hpt, bt	הות, plurality, pass.; בד. limb, 198, 224, 434; ϩⲱⲃ, 154; הו (hu, his), 66; ⲟⲩⲱⲧ, 351.
Woof	ⲙⲟⲩⲧ, מיד	mt	ⲁⲙⲁⲧⲉ, 245; ϫⲓⲙⲙⲟⲩⲧ, 437; ⲙⲛⲧⲉ, medium; G. Æ. 113, 592.
Warp	ⲕⲁⲛ, licium	kp	ϭⲁⲛ, T.S. iii.; ϫⲉⲛ, T.S. xxx.; ϭⲱⲛ, R.S. ix. 40, x. 51; ⲕⲱⲛ, together, 65, 424.
Stay, pecten	ⲕⲛⲃ, חף	kb	ϩⲓⲛⲃ, 268; ⲕⲁⲛ, T. S. xvii.; ϫⲛ, T. S. xx. etc.
Weaver's shuttle	ⲛⲟⲧ	pt, bd	ⲟⲩⲱⲧ, T.S. xxix.; ⲟⲩⲟⲧ, flesh, 340, 414.

Figures.	Names.	Values.	Words and References.
Weaving	κⲁⲡ	kp, kb	ϫⲡⲉ, generation, 169; nation.
Web	κⲱⲃ	kp, kb	κⲱⲃ, 392; ϫⲟⲡ, Pl. ii. 1. [207.

XVIII.—*Agriculture.*

Figures.	Names.	Values.	Words and References.
Plow	ϭⲣⲉ, אכר	kr	ϭⲣⲉ, T. S. ix.; T. B. Pl. xli. *b*.
Pickaxe	ⲙⲁϩⲣⲟ	mr	ⲙⲉⲣⲉ, 164. 435, 338; R.S. pass.; ⲙⲏⲣⲉ, T.S. viii. demot.
Spade	ⲧⲱⲣⲉ	tr	ⲧⲏⲣ, 19, 47, 396, 419; ⲑⲣⲉⲃ, pass.
Sickle	ⲙⲁϭⲟⲩⲗ, מגל	mk	ⲙⲏϣ, מג. 438; *Μάγω*, 438, *b*; עמק. 439, and pass.
Harrow	ⲁⲙⲏ	am	ⲑⲟⲩⲙⲉ, ⲑⲁⲙⲓⲉ, 551, and pass. astron.
Yoke	ⲥⲱϣⲉ, ⲥⲱⲕ	sk	סוג. ⲥⲁϩⲉ, classis, T.S. passim; ⲥⲏϭ, H. O. pass.
Traces	יתר. ⲧⲱⲣ	tr	ⲧⲱⲣ, 274; Caphthor, T. S.; ⲧⲁⲗⲟ, תור. T. S. xvi. xxxiv. etc.
Whip	κⲗⲓⲡⲓ	klp	κⲗⲓⲡⲓ, ϫⲉⲣⲉⲃ, ϩⲣⲃ, image, pass., 299.
Halter	ⲃⲓⲕⲓ	bk	ⲃⲁⲕⲓ, the world; Pl. ii. 4.
Thrashing	דקק. דכא	tk	ⲑⲟϣ, ⲧⲱϭ, regio, provincia, pass.; ⲧⲟϭ, 33; ⲧⲱϣ, 304; ⲧⲱⲕ, robe, 371.
Press	ϩⲉⲙⲓ	hm	ϩⲉⲙⲓ, leader, 348, 384; ϩⲁⲙ, homo, pass.

XIX.—*Arms and other Implements.*

Figures.	Names.	Values.	Words and References.
Warring	ⲙⲓϣⲉ	ms	ⲙⲁⲥ, 199.
Bow	ⲡⲓⲧⲉ	pt	פוט (Put), Libyæ, pass.
Arrow	ϩⲧⲏ, כית	kt	Sate (Kate), ϭⲉⲧϭⲱⲧ, cædere, passim; חטה. triticum, T. S. xxxiii. 186.
Lance	mucro, *μάχαιρα*	mkr	*μακάριος*. Passim. [pass.
Beater	κⲉϩκⲉϩ	kk	κⲉϩ, T.S. xxix.; R.S. ii. 58, &
Plane	ϣⲏⲙ-ϣⲏⲙ	kms	ϣⲉⲙϣⲓ, שמש. worshipping; T. S. xxxiii.; R.S. iv. 7.

This catalogue of 151 syllabic hieroglyphs, nearly all occurring on the Pompeian Tablet, each of which expresses the two or three consonants contained in the name of the figure, will suffice to convince every reader that Ch's theory — "no hieroglyph expresses a syllable"—was a complete failure. Hence it came to pass that Brugsch could not translate this inscription at all, and from which Goodwin only obtained downright nonsense.

HEBREW ROOTS IN THE PREMISES.

It is true, the principal blunder of Ch's theory was his continual negation that any hieroglyphic figure expressed a consonantal syllable; but the second one, that the language of the ancient Egyptians was the modern Coptic, turned out to be not less fatal. The language of the whole ancient Egyptian literature was, as Josephus testifies, *ἱερὰ διάλεκτος*, that is to say, a Hebrew dialect. It is absolutely impossible without the Hebrew, which furnishes the words and grammatical forms wanting in the Coptic, as well as the original orthography and pronunciation of Coptic words, to translate any entire Egyptian text, and hence it came to pass that G. concocted so many absurdities from the Pompeian Tablet.

אגם	agam	ϫωⲙ	kom	kettle, pont.
אגם	agam	ⲕⲁⲙ	kam	reed.
אגם	agem	ⲟⲕⲉⲙ	okem	doleful.
אדון	adon	......	....	lord.
אדיר	adir	ϩⲁⲧⲏⲣ	hater •	magnificent, god.
אור	or	ⲉⲓⲣⲁ	ira	metal, splendor.
אזור	egor	ⲟⲩⲥⲉⲣ	user	girdle.
אזל	agal	ϭⲗⲁ	gla	weaving.
אזל	akal	ϫⲟⲗϩ	kolh	cloth.
אזן	ogen	......	....	ear.
אחר	achar	ϧⲁⲣⲟ	charo	back.
אטד	atad	ⲧⲱⲧ	tot	strengthen.
איש	ish	ⲁϣ	ash	man.
אכל	okel	ϧⲣⲉ	chre	corn.
אכר	ikar	ϭⲣⲉ	gre	plowing.
אל	el	ⲁⲓⲗ	ail	ram, strong.
אל	el	......	....	towards.
אלה	alah	ⲗⲟⲩⲗⲁⲓ	lulai	lamenting.
אלו	alu	ⲁⲗⲟⲩ	alu	pupilla.
אמה	amah	ⲙⲁϩⲓ	mahi	cubit.
אמון	amun	ⲁⲙⲟⲩⲛ	amun	creator.
אמת	emeth	......	....	honesty.
אנא	ana	ⲁⲛⲓ	ani	I, I am.
אנח-נו	anach-nu	ⲁⲛϧ-ⲛ	anch-n	our souls, we.
אנוש	enosh	ⲟⲛϧ	onch	I am.
אנקה	anaqah	ⲉⲛⲁϣⲉ	enashe	lizard, many.
אף	ap	ⲁⲟⲩⲱ	awo	also.

אפוד	epod	ⲉⲫⲟⲩⲧ	ephut	mantle.
אפן	open	......	....	time.
אצבה	ekbah	ⲧⲉⲃ	teb	finger.
אצל	ekel	......	....	neighboring.
אצר	akar	ϫ̀ⲁⲗⲁ	chala	fortress.
אקא	aqa	ϭⲓⲏ	kie	goat.
אקדה	aqadah	ⲁϫⲑ	akth	duck.
אקדה	aqadah	......	....	ἀκτίς, glance.
ארון	aron	ⲣⲁⲛ	ran	box.
אתה	athah	......	....	coming, going.
באר	baar	ⲃⲱⲣ	bor	well, fountain.
בבה	baba	ⲃⲏⲃ	beb	cave.
בג	bag	ⲁ(ⲃ)ⲉⲓⲕ	a(b)ik	bread, βέκος.
בד	bad	ⲟⲩⲉⲧ	wet	separating one.
בד	bad	ⲟⲩⲁⲧϩⲓ	wathi	thread.
בד	bad	......	....	limb.
בדא	bada	ϩⲟⲡⲧ	hopt	devise, join.
בהו	bohef	ⲃⲉⲃⲉ	bebe	empty.
בית	beth	ⲁⲩⲉⲧ	awet	house, domicile.
בעל	baal	ⲟⲩⲱⲗⲉ	wole	lord, mighty.
בקר	biqer	......	....	watching.
בת	bath	ⲫⲁⲧ	phat	fat, vat.
בת	bath	......	....	female, virgin.
גו, גב	gab, gaf	(ⲁ)ϩⲟⲩ	(a)hv	back, G. Buck-el.
גב	gab	ϭⲃ	gb	nose, hump.
גבא	gebe	ⲕⲏⲃⲓ	kebi	basin.
גביע	gabia	ϫⲟⲡ	kop	vase.
גדד	gadad	ϭⲉⲧϭⲟⲧ	getgot	cutting.
גהר	gahar	ϭⲁⲣⲓ	gari	striking.
גהר	gahar	ϣⲁⲓⲣⲓ	shairi	genuflecting.
גוב	gub	ϣⲟⲩⲟ	swo	flowing.
גול	gul	ⲕⲉⲗ	kel	rolling.
גור	gur	ϫⲱⲓⲗⲉ	koile	dwelling, χώρα.
גור	gur	ϩⲟⲩⲣ	hur	fearing, revering.
גזז, גזה	gagag	ⲕⲉϩ-ⲕⲉϩ	keh-keh	cutting.
גידא	gida	ⲥⲟⲧⲉ	sote	ϩⲓⲧⲉ, thread, spinning.
גיל	gil	ϭⲉⲗ	gel	vase, גלה (galah).
גיל	gil	καῖρος	ⲕⲉⲗ	time.
גיל	gil	ϣⲁⲓⲣⲓ	χαίρω	exulting.
גיר	gir	......	....	limestone.
גל	gol	ϭⲉⲗ	gel	vase.
גל-גל-ת	gulgoleth	ⲕⲁⲣⲁ	kara	skull.
גלב	galab	ⲕⲗⲓⲡⲓ	klipi	cailare, γλύφειν.
גלה	gelah	ϭⲉⲗ	gel	vase.
גלל	galal	ⲕⲗⲱⲗ	klol	vase, urceus.
גלל	galal	ϩⲗⲱⲓⲗⲓ	kloili	bearing.

גמא	goma	ϫⲱⲙ	ⲕⲁⲙ	papyrus.
גמל	gamal	ϭⲁⲙⲟⲩⲗ	gamul	camel.
גן	gen	ϣⲏⲛ	shne	garden.
גרה	gerah	ϩⲓⲣ	ϩⲓⲣ	גרגר, grain.
דב	tob	ϣⲁⲩ	shav	good.
דדה	dadah	ⲧⲟⲟⲧⲉ	toote	walking.
דור	dor	......	....	time, period.
דוש	dosh	ⲧⲟϣ	dosh	statera, ⲧⲁϩⲟ.
דכא	daka	ⲧⲁϩⲟ	taho	ⲧⲱⲕ, fixing.
דמה	damah	......	....	image.
דרר	darar	ⲑⲣⲉ	thre	turning, making.
הגה	haga	ϩⲓⲕ	hik	dæmon.
הו, הוא	hva	ⲉϥ, ⲁϥ	(h)af	he, he is, he was.
הוד	hod	ⲟⲩⲟⲧ	(h)wot	vigorous.
הלל	halal	ϩⲉⲗⲟⲗⲓ	heloli	jubilant.
הלל	halal	ⲉⲓⲉⲗⲉⲗ	helel	clearing, splendor.
הון	hon	ϩⲱⲛ	hon	mighty, ruler.
ו	hf	ⲉϥ	ef	being.
ו	hf	ⲁⲩⲟ	avo	and.
ות	woth	ⲟⲩⲁⲧⲁ	wata	plurality.
זבח	gebach	ϣⲉⲩⲉ	sheve	sacrifice, altar.
זהב	gahab	ϣⲱϩⲉⲃ	shoheb	glistering.
זהר	gahar	ϫⲉⲣⲉ	kere	burning, splendor.
זוב	gub	ϣⲟⲩⲟ	shvo	flowing, effunding.
זר	ger	ⲕⲣⲟ	kro	border.
זרע	gero	ϧⲣⲉ	chre	seed.
זרע	gara	ϭⲉⲣⲉ	gere	sowing.
(מ)זרק	(mi)graq	ⲕⲁⲣⲩⲕ	kalyk	chalice, G. Glocke.
זרת	gereth	ⲉⲣⲧⲱ	erto	span.
חבא	chaba	ⲭⲉⲛ, ϩⲟⲛ	chep	absconding.
חבת	chaboth	ἔπτω	hepto	baking.
חג	chog	ϣⲁⲓⲟ	shago	feast.
חגור	chagor	ⲟⲩⲉⲉⲣ	chuger	girdle.
חוט	chut	ϩⲓⲧⲉ	hite	sewing.
חוט	chut	ϩⲱⲥ	hos	thread.
חול	chul	ⲕⲉⲗ	kel	dancing, turning.
חול	chol	(ϩ)ⲟⲗ	hol	stone, sand.
חול	chol	ⲁⲗⲗⲱⲛ	halloe	phœnix.
חול(ל)	chule(l)	ⲧⲉⲗⲉⲗ	telel	dancing, rejoicing.
חום	chum	ⲕⲏⲙ	kem	black, dark.
חור	chor	ⲕⲟⲣⲓ	kori	window.
חטה	chitah	ⲓⲱⲧ	iot	barley, hordeum.
חטה	chitah	ⲥⲁⲧⲉ	sate	sown field.
חטם	chatam	ⲑⲱⲙ	htom	muzzling.
חית	cheth	ϩⲁⲉⲓⲧ	hait	vestibule.
חך	chek	ϧⲁϧ	chach	palate.

חלל	chalal	ϭⲉⲗϭⲟⲗ	chelchol	killing.
חלל	chalal	ⲗⲟⲩⲗⲁⲓ	(h)lulai	trumpeting.
חם	chom	ϩⲏⲙ, ϣⲱⲙ	chom	warmth, summer.
חמד	chemet	ϩⲙⲟⲧ	hmot	beauty.
חמין	chomek	ϩⲙϫ	hamk	vinegar.
חמר	chamar	ϣⲉⲙⲏⲣ	shemer	leaven.
שמר	shemer	ϣⲉⲙⲏⲣ	shemer	leaven.
חף Rab.	chop	ⲕⲁⲡ	kap	pecten pedis.
חפף	chapap	ⲃⲏⲃ	(h)beb	covering.
הצר	chakar	ⲕⲉⲣ-ⲥⲟ	kerso	vestibule.
חקה	chaqah	ϩⲱⲕ	hok	cutting.
חרת	charath	ϭⲉⲗⲗⲟⲧ	chellot	incision, valley.
חצר	cheker	ⲕⲉⲣ-ⲥⲟ	cherso	vestibule.
חתה	chathah	ϩⲟⲧⲉ	hote	fearing.
חתול	chathul	ⲁⲑⲱⲣ	hathor	cat, G. Kater.
טוב	tob	ⲧⲟⲩⲃⲟ	tubo	good. clean.
טלל	talal	ⲧⲗⲏ	tle	founding.
טנא	tene	......	....	basket.
ידע	yada	ⲕⲁϯ	kati	knowing.
ילד	ialad	ⲭⲣⲟϯ	chroti	begetting.
ים	yim	ϫⲟⲙ	kom	plurality.
יצא	yeka	ϫⲟⲕ	kok	finishing.
יתר	ither	......	....	traces.
באב	keeb	ϩⲏⲃⲓ	hebi	lamentation.
יאר	yeor	ⲓⲁⲣⲟ	yaro	river
כבד	kebod	ⲥⲟⲩⲃⲏⲧ	subet	honor.
כבד	kabad	ϣⲫⲓⲧ	sphit	revering.
כהן	kohen	ϩⲟⲛ-ⲧ	hoṇ-t	priest.
כון	kun	......	....	posted.
כו-כב	kokab	ⲥⲓⲟⲩ	siv	stare.
כור	kur	ⲉϩⲣⲱ	chro	stove.
כיד	kid	ϫⲁⲧ-ϥⲓ	kat-fi	snake.
כיד	kid	ϩⲧⲏ	hte	arrow.
ככה	kaka	ⲕⲱ	ko	likeness.
כל	kol	ⲕⲟⲗ	kol	together.
כלה	kalah	ϩⲟⲩⲣⲟ	huro	deficiency.
כלה	kalah	......	....	intercalate.
כלוב	kelub	......	....	corbis.
כלי	keli	ϭⲗ	gl	child.
כלי	keli	ϭⲗ	gl	raiment.
כליל	kalil	ϭⲁⲗⲓⲗ	galil	burnt-offering.
כלף	kalap	ⲕⲗⲓⲙ	γλύφειν	forming, image.
כמן	kamon	ⲑⲁⲓⲙⲟⲩⲛ	cuminum	cumin.
כסא	kise	ϩⲓⲥⲉ	hise	throne.
כף	kap	ϭⲟⲡ	gop	pecten, vola.
כף	kap	......	....	coffer.

כפף	kapap	ⲕⲁⲡ	kap	weaving.
כפתור	kapthor	......	....	Cyprus.
כרה	kara	ϭⲣⲏ	gre	ditching.
כרע	kara	ϭⲣⲁ	gra	shank, crura.
כרע	karak	ⲕⲉⲗϫ	kelk	genuflection.
כרת	karath	ϭⲟⲣⲧ	gort	character.
כרת	karath	ϭⲟⲣⲧⲉ	gorte	knife.
כרת	karath	ϭⲟⲣⲧⲉ	gorte	conqueror.
כתנ(ת)	kethon-(eth)	ϣⲑⲏⲛ	shthen	χιτών, cotton.
לא	lo	ϩⲗⲓ	hli	not, no.
לקק	laqaq	ⲗⲁⲥ	las	tongue, G. Lecke.
מ	ma	ⲙⲁ	ma	place.
מאן	mean	......	....	since, indea.
מג	mag	ⲙⲉϩ	meh	multitude, ⲙⲉϣ.
מג	mag	ⲙⲏϣ	mesh	venerable, Manes.
מדה	madah	ⲙⲁⲧⲉ	mate	mighty.
מוח	moach	ⲙⲟⲕ-ⲙⲉⲕ	mok-mek	thinking, considering.
מוצא	moka	ⲙⲁϣⲓ	mashi	orient, east.
מזח	magach	ⲙⲟϫϩ	mokh	girdle.
מח	moach	ⲙⲟⲕ	mok	brain, thinking.
מחא	macha	ⲙⲓϣⲉ	mishe	battling.
מין	min	ⲙⲉⲛ	men	from.
מלא	melo	ⲙⲁⲣⲓⲥ	maris	basin.
מלח	melach	ⲙⲏⲣⲉ	mere	mare, sea.
מלך	melek	......	....	king.
מלך	melek	......	....	queen-bee, μέλιττα.
מלכת	meleketh	......	....	queen.
מנה	mana	......	....	offering.
מני	meni	ⲙⲁⲛ	man	moon, μήν.
מנע	mana	ⲁⲙⲟⲛⲓ	amoni	taking.
מסע	masa	ⲙⲏϣ	mesh	mason.
מעה	megeh	ⲙⲁϧ(ⲧ)	mach(t)	entrails.
מצה	makah	......	....	sweet, G. Mazen.
מרר	marar	ⲙⲏⲣⲉ	mere	mare, sea.
נבא	naba	ⲛⲁⲩ	nav	seer, prophet.
נבה	nabah	ⲛⲉⲃ	neb	lord.
נבו	nebo, ⲛⲏϥ	Ἄνουβις	Mercury	the dark one.
נבל	nebel	ⲛⲟϥⲣⲓ	nofri	nablium, good.
נגע	naga	....	....	striking.
נדה	nida	....	....	lustration.
נוף	nop	....	....	eminent.
נטה	natah	....	....	suppressed.
נפח	napach	ⲛⲓϥⲓ	nifi	respiration.
סבא	saba	ⲥⲁ(ⲩ)ⲁ	sa(v)a	G. sauf-en, drinking.
סוג	sug	ⲥⲁϩⲉ	sahe	division.

סכות	sikuth	....	....	cabin.
עב	gab	ϭⲏⲛⲉ	gepe	cloud.
עבדה	abotah	....	....	office, service.
עבט	abat	ϣⲓⲃϯ	ⲁⲃⲟⲧ	mutation, year.
עגה	gugah	ϫⲱϫ	kok	cake, ⲕⲟⲧⲕⲉ.
עגל	egel	ⲁϭⲟⲗ	agol	calf.
עגלת	egloth	ⲁϭⲟⲗⲧⲉ	agolte	chariot, wagon.
עדה	edah	ⲁⲧⲁ	ata	multitude, host.
עדן	eden	....	....	garden
עוד	gud	ⲕⲱⲧ	kot	return, again.
עול	gul	ϣⲏⲣⲓ	sheri	χόρος, child.
עוף	gup	ⲁϥ	(g)af	flying, fly.
עור	iver	ⲃⲉⲗⲗⲉ	belle	blind.
עור	gor	ϣⲁⲣ	shar	skin, hide.
עור	gur	ⲉⲓⲣⲁ	ira	aes, ore.
עז	geg	ϭϩⲟ-ⲥ	kho-s	goat.
עזז	agag	ϫⲱϫ	kok	strong, mighty.
עטר	gatar	ϩⲱⲧⲣ	hotr	sheaf, bundle.
עיר	gir	ϩⲓⲣ	hir	city, fort.
על	gal	ϩⲣⲁⲓ	hrai	adding, upon.
עלה	golah	ⲱⲗ	ol	lifting, oblation.
עמק	emeq	....	....	valley.
ענד	anad	ⲛⲧⲉ	nte	and, together.
ענד	anad	....	....	handle.
ענה	gana	ϭⲉⲛ-ϭⲛ	gen	cane-re, singing.
עץ	ek	ϣⲏ	she	tree, branch.
עצד	akad	ϭⲉⲧ, ϣⲟⲧ	ged	cæd-ere, cutting.
עצן	akan	....	....	strong, hard.
עצר	oker	ⲕⲗⲏ	ⲟⲩⲉⲉⲣ	coffin, girdle.
עקב	aqab	....	....	following.
עקל	aqal	ϭⲟⲗϩ	golh	cloth.
עקר	aqar	ϣⲓⲣⲉ	shire	sterility, famine.
עשה	asah	ⲉϣⲱ	esho	bristly, σῦς, sus.
פאה	peah	ⲫⲏ	phe	heaven, region.
פג	pag	ⲃⲉϣ	besh	immature figs.
פגע	paga	....	....	begging.
פדד	padod	ⲟⲩⲟⲧ	wot	divide, one.
פז	pag	ⲡⲥⲉ	pise	burning, purifying.
פח	pach	ⲡⲁϣ	pash	cord, rope, filament.
פחה	pacha	ⲃⲱⲕ	bok	ruler, king.
פחז	pachag	ⲃⲟϭ, ϥⲉϭ	bog	springing, dancing.
פנה	panah	....	....	considered.
פשתה	pishthe	....	....	flax.
פתה	pathah	....	....	prophesying.
צבא	kaba	ⲧⲃⲁ	tba	legion.
צהב	kahab	ϣⲱϩⲃ	shohb	flame, lightning, holocaust.

צהל, צהר	khl, khr	ϩⲣⲁ	hra	light, sun.
צהל	kahal	ϣⲁⲓⲣⲓ	*χαίρω*	jubilation.
צהר	kohar	ϫⲉⲣⲉ	kere	south, burning.
צוד	kud	ϭⲱⲧ	kot	fish, fishing.
צי צוה	kava	ϫⲟⲟⲩⲓ	kovi	cippus, skiff.
צור	kur	ϫⲣⲟ	kro	hard, pressing, etc.
צור	kur	ϫⲉⲣ	ker	sharpening.
צור	kor	ϫⲟⲣ	kor	fortress.
ציין	kik	ⲕⲉⲕ	kek	plate.
צלח	kalach	ϭⲉⲗ	kel	bowl, platter.
צלח	kalach	ϩⲗⲏϫ	hlek	sweet, happy.
צליעא	kliaga	ϣⲟⲗϩ	sholh	cross.
צלל	kalal	ⲕⲗⲟⲟⲗⲉ	kloole	obscuration, fog.
צלע	kelo	ϭⲁⲗⲉ	gale	lame.
צלצל	kelakal	(ϣ)ⲕⲉⲗⲕⲓⲗ	kelkil	tinkling.
צמח	kamach	ϫⲙⲉ	kme	generare.
צמח	kemach	....	....	from the beginning.
צנן	kanan	....	....	watching, caring.
צעדה	keadah	ϩⲓⲧⲉ	hite	cæte(na), chain.
צפע	kapa	ϩⲱⲃ, ϩⲟϥ	hob	snake.
צפר	kapar	ⲧⲁⲃⲏⲣ	taber	dancing.
צר	kar	ϭⲟⲣ-ϭ	gor	enemy.
צרה	karah	(ⲕ)ⲣⲏ	(k)re	portion, division.
צרעה	kirgah	ϣⲁⲗⲟⲩⲕⲓ	shaluki	wasp.
קב	qab	ϣⲏⲡⲉ	shipe	cabus, mensura.
קב	qab	ϭⲟⲡ	gop	coffer.
קבה	kubah	ⲕⲩⲡⲏ	kype	chamber.
קבע	qaba	ϫⲓⲟⲩⲉ	kiwe	stealing, robbing.
קו	kaf	ϣⲃⲱ	shbo	cord, ⲕⲁⲡ.
קומה	qomah	ϣⲉⲙ	shem	altitude.
קוף	qop	ϫⲱϥ	kof, (ϩ)ⲁⲡⲉ	caput.
קנה	qana	ⲟⲩⲟⲛ	won	having.
קנה	qana	ⲕⲏⲛ	ken	creating.
קרא	qara	ϧⲁⲣⲁ	kara	crying, ϣⲁⲗ.
קרת	qarath	ϭⲟⲣⲧⲉ	gorte	knife.
רגע	ragea	ⲣⲁϣⲉ	rashe	quietness, joy.
שׁאל	shaal	ϣⲗⲗ	shalal	praying.
שׁבע	sheba	ⲥⲁ(ϣ)ⲃⲉ	sabe	seven.
שׁגל	shagal	....	....	concubuit.
שׁוא	shava	ϣⲁϥⲉ	shafe	desert, desolation.
שׁוב	shub	ⲥⲟⲡ	sop	again.
שׁוה	shivah	ϣⲟⲡ	shop	making, creating.
שׁור	shor	ⲕⲁⲗ	kal	bos, bull.
שׁין	shen	....	....	tooth.
שׁישׁ	shesh	ϣⲉ(ⲛ)ⲥ	shes	byssus.
שׂכר	sakar	ϣϭⲉⲣ	shger	deed, prize.

שם	shem	ⲥⲙⲟⲩ	smu	name, celebration.
שמע	shama	ⲥⲙⲏ	sme	hearing.
שמנה	shemona	ϣⲙⲟⲩⲛ	shmun	eight.
שמש	shmash	ϣⲉⲙϣⲓ	shemshi	ministering.
שנה	shanah	....	....	splendent.
שנים	shnaim	ⲥⲛⲁⲩ	snau	two.
שפה	sapah	ⲥⲫⲟ-ⲧⲟⲩ	spho-tu	lip.
שעיר	sair	ϣⲁⲣ	shar	capricornus.
שער	sear	ϣⲁⲣ	shar	hair, hairy.
שק	saq	ⲥⲟⲕ	sok	sack.
שרבית	sherbit	ϣⲉⲣⲃⲱⲧ	sherbot	sceptre.
שרף	sarap	....	(serpens)	burning.
שרש	sheresh	ϣⲣϣⲣ	shersher	ϣⲁⲣ, eradicating.
שש	shesh	ⲁⲥⲉ, ⲥⲟ	ase, so	sex.
שש	shesh	ϣⲉ(ⲛ)ⲥ	shes	byssus.
שת	sheth	ϣⲟⲧ	shot	cushion.
ת	th	ⲧⲉ, ϯ, ⲧⲏ	te, ti	artic. fem. *illa.*
תבה	theba	ⲑⲃⲁ	thba	box, ⲧⲁⲓⲃⲓ.
תו	thaf	ⲧⲱⲃ	tob	signing, cross.
תו	thaf	ⲧⲟⲟⲩ	tov	mount.
תו	that	....	....	dwelling, house.
תוה	thafa	....	....	residing, residence.
תור	thor	....	....	cyclus.
תלע	thalk	....	....	breast, θώραξ.
תנה	thana	ⲧⲁ(ⲛ)ⲓ	ta(n)i	giving.
תקע	thaka	ⲧⲁϣ, ⲧⲁϩⲟ	tash	establishing.
תורה	thorah	? ⲧⲁⲗⲟ	talo	law, constitution.
תר(ן)	thor(en)	ⲧⲁⲣ	tar	mast, of which the root is ⲧⲱⲣ, *infigere*, and not רנן (ranan). *sonum tremulum et stridulum ededit*, as Gesenius imagined. Lex. 861.

This catalogue of nearly 400 Hebrew words occurring on the Pompeian Tablet, the Tanis Stone, and some other inscriptions, will suffice to convince the reader that the Egyptian language originated from the primitive Hebrew. If it had been necessary, it would have been an easy matter to have reduced a much greater number of Coptic words to Hebrew roots. We predict, moreover, that our Hebrew Dictionaries will, sooner or later, undergo the more corrections and improvements, the more Egyptian texts will have been grammatically translated.

THE QUESTIONS.

Having seen with his own eyes what nonsense the Pompeian Tablet contains if translated according to Ch's system, the reader is urgently requested to answer the following questions, without which the truth will never come to light.

I. Is it true that Ch. discovered the key to the Egyptian literature, or is it false what the Champollionists honestly confessed in 1845 (Bunsen's Egypt; see also the passage p. 197 in the premises), that it is absolutely impossible to grammatically translate any entire hieroglyphic text by means of Ch's theory? Is it true that the latter was, in this respect, a complete failure, as two intelligent Egyptologists, Prof. M. Uhleman in Göttingen and Prof. H. Wultke in Leipzig, have constantly maintained? Is it a fact that Ch., from 1824 down to his death in 1832, failed to translate the bilingual R. S. by means of his theory? Is it true that the great Ch't B. could not interpret, with the exception of two words, the Pompeian Tablet? Is it true that G. could not translate 79 words of the Pompeian Tablet notwithstanding Ch's "Key" to the Egyptian literature, and that his interpretation of the remaining 330 words of the same text contains downright nonsense? Has the bilingual Tanis Stone, discovered 42 years after the publication of Ch's Précis, confirmed or refuted this system?—It is to be taken into consideration that L. could not translate 440 hieroglyphs of the T. S. at all; that he adopted Ch's 201 phonetic hieroglyphs without knowing that 93 had turned out to be wrong; in consequence of which he brought out a great many monster-words occurring neither in the Coptic nor in any other language of the world, e.g.[1] *aaan*, cynocephalus; *aaaiu*, time; *aaau*, arms; *uau*, to well; *uaa*, swearing; *tuau*, praising; *ou*, all; *oau*, office; *oou*, dignity; *aa*, chief; *u*, way; *oau*, flesh; and a legion of similar chimeras in Brugsch's Dictionary. The same interpreter of the same inscription translated, according to Ch's system, Cyprus by "Phœnicia," Phœnicia by "Cyprus" (כאפתור kapthor), Chaldea by "of it," Asia by "valley," Syria by "Ruten," Greek by "book," demotic by "Greek," and so on. Moreover, at the same time another translation of the T. S. appeared, that of Reinisch, which, though based upon the same system of Ch., totally differs from L. These practical proofs will certainly enable every sane man to answer the question, whether Ch's theory is the key to the Egyptian literature or not. Ch. has his merits, but it is shameful to change a mosquito into an elephant. Let us now come to Ch's fundamental mistakes.

II. Is it true that the Egyptian hieroglyphs originated from the primitive ideologic writing, or rather is the Noachian alphabet of 25 letters the basis of them? Ch. proceeded on the flattering idea that the first man was not "created in the image of God," but was procreated by an ape some millions of years ago, and it is probable that he with his own eyes had seen how this first rational being was developed from the monkey. Accordingly, of course, the art of writing, says Ch., must have commenced with figurative signs, but, after some millions of years (about 1500 years B.C.), Cadmus invented our phonetic letters, totally unknown to the Egyptians (6,000 years B.C.) All these fixed ideas are contradicted by history. For history reports that 900 years before the deluge, which was not "confined to but a small portion of our globe,"* a book already existed; the Koran asserts that Noah wrote a book; in the Vedas and Avesta we read that the antediluvian books were lost, in consequence of which the human race became wicked, and therefore God resolved to extirpate it. Pliny mentions "æternum literarum usum," and, according to the ancient historian of the Chaldeans, a heavenly deity, prior to the deluge, delivered the art of writing, geometry, and other sciences, to the human race. The same Berosus narrates that Sisustro, in whose days the deluge took place, wrote books. Even Diodor (de comp. verb. v. 57) and Tzetzes (Chil. v. 28) testify to the loss of the antediluvian books. All these traditions concur in demonstrating that prior to the deluge both an alphabet and written works existed; and who is able to believe that human society during a period of 2424 years would have remained unable to represent the elements of their spoken words by certain characters?

We proceed now to the reports according to which the general alphabet of 25 letters, inclusive of 7 vowels, was saved by the man who outlived the deluge. First, ancient Berosus of Chaldæa tells that Sisustro (Noah) referred the primitive alphabet to the Zodiac, and, subsequent to the deluge, delivered the same to his posterity. This is confirmed by the fact that the alphabets of all ancient nations agree with each other concerning the consecution of the letters (*a*, *b*, *c*, ... *u*), the number of the consonants and vowels, their names and characters, as has been demonstrated

* Pojana, "Della universalità del Diluvio." Poligrafo di Verona, 18[illegible]. Vol. xi. p. 245.

in the writer's *Alphabeta genuina*, Leips. 1840. Even the basis of the hieroglyphs was, as Plutarch bears witness, an alphabet of 25 letters with 7 vowels, of which the first was our A. See Pl. xxxii. *b*, Nos. 450–56, where the coincidence of the primitive (Phœnician) letters with the Egyptian hieroglyphics is demonstrated *ad oculos*.

Eusthadius, one of the most enlightened savans of Greece, says (Il. *b*. 841) the Pelasgi alone are said to have saved the alphabet at the time of the deluge (*κατὰ τὸν κατακυσμὸν σῶσαι τὰ στοιχεῖα μόνους*), and those Pelasgi (r. *Πέλαγος*) were the Noachides who came from the antediluvian to the postdiluvian world by "shipping." The same we read in Syncell's Chronogr. p. 40, ed. Goar. Par. 1652.

Cadmus, i.e. the ancestor (r. קדם, kadam), the mythologists report, invented the letters by sowing the teeth of the heavenly dragon (the Zodiac), and from these teeth 50 giants originated, i.e. 25 letters running from the left to the right hand, and 25 others being transverted (*βουστροφηδόν*). These 50 heros reduced themselves to 5 (the labiales, linguales, dentales, nasales, gutturales), by whom the ancestor constructed Thebes, the ancient emblem of science. The same Cadmus was the first planter of a vineyard, like Noah. Remember, moreover, what Strabo (x. 3, p. 474) says, "the ancients veiled their physical conceptions by riddles, and added myths to their scientific contemplations."

This Cadmus, it is true, was, according to the ancients, a Phœnician, but do not forget that Pliny distinguishes the Phœnicians near the shore of the Mediterranean Sea and those "ab æterno," who are the Noachides, the ancestors of all nations. For this name refers to the root בנה (banah), progenitor. See Eusebe Præp. Ev. ii. p. 39, ed. Vig., where Noah is called *πρῶτος Φοινίκιος*.

The same invention of the alphabet the Parsees referred to Kaiomorts, the ancestor of the human race. According to the Indians, Menu, the ancestor of all nations, wrote a book. The Chinese report that Tohi, in whose days "the wells of the depth opened and the columns of heaven broke down," who was "saved together with his seven saints," and after the deluge lived 150 years more, invented both the alphabet and astronomy.

The clearest tradition in the same respect, however, is that of the famous historian of the Phœnicians, Sanchuniathon, who (Euseb. P. E. i. 10) says that Taout, i.e. the wise one (דעת. daoth), the tenth descendant of Protogonos, i.e. Adam (Noah was likewise the tenth descendant of Adam), determined the characters of the sacred alphabet in accordance with the signs of the Zodiac. *Θεὸς Τάαυτος, μιμησάμενος τὸν οὐρανὸν, τῶν θεῶν ὄψεις—Κρόνου τε καὶ Δαγῶνος, καὶ τῶν λοιπῶν—διετύπωσεν τοὺς ἱεροὺς τῶν στοιχείων χαρακτῆρας.* To wit. *Ὄψεις θεῶν*, פנים (panim), even mentioned on the Pompeian Tablet, facies of the planets, are the houses of the planets, the 12 signs of the Zodiac. Consequently the first 24 letters of the Noachian alphabet made full the 12 signs, and the 25th letter coincided with א (alpha), the first.

Further, it is self-evident that the first two letters of the alphabet were to be referred to the first sign of the Zodiac, which was, at that time, Taurus. Hence both the first letter of the alphabet and the first sign of the Zodiac were termed אלף (alep), taurus.

Moreover, since the 7 planets of the ancients (Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon) constantly occupy certain signs of the Zodiac, it is likewise apparent that the 7 vowels of the ancient alphabets, viz. *a ä e ë i o u*, must have signified the 7 planets. Again, from Laurentius Lydas, Nicomachus Harmonicos Manuale L. i. & ii., Irenæus c. Her. i. c. 14, 7, Pliny, Pythagoras (Harmon. Man.), from a Leyden papyrus, and the natural consecutions both of the vowels and the planets, we learn that the former expressed the following planets:

a = ☽, *ä* = ♀, *e* = ☉, *ë* = ☿, *i* = ♂, *o* = ♃, *u* = ♄.

Accordingly, the first letter of the alphabet being referred to the first sign of the Zodiac, Saturn and the moon must have stood in Taurus, and this is confirmed by a very old tradition of the Greeks. They celebrated every 30 years, as often as Saturn returned to the sign of Taurus, great festivals in remembrance of the deluge "during which Saturn had appeared in Taurus."

Now, referring the 7 planets, mentioned in the Noachian alphabet, to the aforesaid signs of the Zodiac, we obtain the following planetary configuration, which, as every astronomer knows, can return but after 2146 years, and this refers, as seen by the subjoined computation, to the year 3446 B.C., Sept. 7.

		Ancient Observation.	Computation.
Saturn	*u*	1^s 0° — 15°	1^s 0° 21′
Moon	*a*	1^s 0° — 15°	1^s 13° 41′
Jupiter	*o*	9^s 15° — 30°	9^s 29° 37′
Mars	*i*	6^s 15° — 30°	6^s 17° 22′
Sun	*e*	4^s 15° — 30°	4^s 16° 9′
Venus	*ä*	3^s 0° — 15°	2^s 29° 48′
Mercury	*ë*	5^s 0° — 15°	5^s 4° 30′

In the same year and on the same day the deluge came to an end according to the chronology of the Septuagint. The subject has been discussed more *in extenso* in the writer's "Unser Alphabet," etc. Leipz. 1834; "Unumstaesslicher Beweiss," etc. Leipz. 1839; "Summary of Recent Discoveries," etc. N. Y. 1857.

All these historical reports and infallible astronomical computations put it beyond question that our alphabet existed prior to the deluge, that it was newly arranged by Noah, and the Egyptian literature (originating 666 years after the deluge, in 2780 B.C., since Menes' arrival in Egypt) must have been derived from the primitive alphabet of 25 letters, and not, as Ch. fancied, from the primitive ideologic writing. It would have been impossible to represent at least 10,000 Egyptian words by the instrumentality of 630 ideologic figures.

III. Is it true that Clement of Alexandria (Strom. l. v. 4, p. 657, Potter) divides the Egyptian hieroglyphs into two classes, viz. phonetic and ideologic ones? The particular passage reads thus: "The pupils of the Egyptians learn the hieroglyphic method of writing — ἧς ἡ μέν ἐστι διὰ τῶν πρώτων στοιχείων κυριολογική, ἡ δὲ συμβολική. Τῆς δὲ συμβολικῆς ἡ μὲν κυριολογεῖται κατὰ μίμησιν, ἡ δὲ ὥσπερ τροπικῶς γράφεται, ἡ δὲ ἀντικρὺς ἀλληγορεῖται κατά τινας αἰνιγμούς." Ch. imagined συμβολικός to signify ideologic, i.e. not phonetic. This is, however, a gross blunder. The ancient Greeks never used the word συμβολικός to express ideologic — what, at present, passes for "symbolic." Συμβάλλειν and συλλάβειν are synonyms; accordingly συμβολικός signifies syllabic. This is evident from the context as well as from other testimonials; for from the following words: some hieroglyphs κυριολογεῖται διὰ τῶν πρώτων στοιχείων, clearly evidence that Clement took κυριολογεῖν for *pronouncing by means of the primitive* (Noachian) *alphabet.* Now, the same word κυριολογεῖν is applied to express the value of the so-called "symbolic hieroglyphs"; and hence it is self-evident that ideologic hieroglyphs can indeed express ideologically an idea, but never *pronounce* the latter, it not being pronounceable. Further, the crescent, as Clement says, signifies the moon—*κατὰ τὸ κυριολογούμενον εἶδος*—because the name of the crescent was *man*, the Greek *μήνη*, the Hebrew *meni*, etc., and hence it expressed phonetically, viz. syllabically, the name of the moon, *man*, *μήνη*. This is confirmed by numberless inscriptions, particularly by the group of the crescent (*mn*), star (*k*), and hand (*t*), which express the letters *mn kt* (man kot), revolution of the moon, i.e. month. The name of Menes was likewise expressed by the crescent, of course by the letters *mn*.

Furthermore, Cosmas Indicopleustes (Cosmogr. p. 161, ed. Montf.) bears witness that the hieroglyphs *οὐκ εισι γράμματα, μάλλον γραμμάτων σύμβολα*—that is to say, the hieroglyphs expressed syllables. Had he taken *συμβολικός* for ideologic, the Egyptians would have expressed a phonetic character ideologically, which is downright nonsense.

Again, Cassiador (Chron. ad Theod. regem) says: "Obeliscorum prolixitas ad Circi altitudinem sublevatur, ubi sacra Priscorum Chaldaicis signis, *quasi literis* indicantur." Consequently the Egyptian hieroglyphs must have originated in Chaldæa prior to the dispersion of the nations, and this is confirmed by the R. and T. stones. They call the demotic letters only *Ἀιγυπτιακά* and *ἐνχώρια*, domestic, and so they report implicitly the hieroglyphic writing to have originated in the primitive fatherland of Menes and his family, namely, in Chaldæa. Indeed, from the same country the Chinese, Japanese and Mexicans proceeded, and their manner of writing was likewise a syllabic one, as I learned from Guitzlaff, the most erudite Chinese scholar of modern times. The Chinese expressed, e.g., the name of the city of Cassel by two Chinese hieroglyphs, of which the first sounded *cas*, the second *sel*.

This gross misconception of Clement's reports is the fatal basis of Ch's hieroglyphic system. It is self-evident that as soon as we interpret Clement, Cosmas, Cassiador, the R. and T. stones, as they read, the system of Ch. crumbles into dust.

IV. Is it true that each hieroglyphic text consists half of ideologic, half of alphabetic hieroglyphs? The afore-mentioned πρῶτον ψεῦδος seduced Ch. to state that; and in his Egyptian Grammar an illustrating plate will be found. However, the R. S. and T. S. do not contain *one ideologic hieroglyph.* The very same is the case with the Pompeian Tablet, as will be seen in the premises. It is an absurd imagination that the very same 630 hieroglyphs expressed in one place a simple letter, in others a whole word ideologically.

V. Is it true that regularly each hieroglyphic word is followed by one or more ideologic figures indicating what class of things the foregoing group or word belongs to? On this fallacious presumption, based upon the said misinterpretation of Clement, the Dictionary and Grammar of Ch., those of B., and the numberless translations of the Chts., are founded. And hence it resulted that those dictionaries and translations contain scarcely one word of truth. We refer to the facts mentioned under No. IV. in the premises.

VI. Is it true that no hieroglyphic figure expresses a syllable, or is it true that regularly each of the 630 hieroglyphs signifies the consonantal syllable contained in its name? Ch. from his first to his last work taught that no hieroglyph expressed a syllable, as the numerous passages quoted in the writer's Grammatica Ægyptiaca, Gotha, 1855, pp. xvii. xviii., evidence. The answer of this question will be found on the Rosettana which contains 490 syllabic hieroglyphs, on the T. S. containing 1340 syllabic figures, on the Pompeian slab with its 377 syllabic images, as we have seen, pp. 260–68. Everybody will see with his own eyes that all these 2207 syllabic hieroglyphs express the two or three consonants contained in the respective names of the hieroglyphs. Since then, on an average, every hieroglyphic inscription contains 60 syllabic figures in 100 hieroglyphs, whilst Ch. constantly denied the existence of syllabic hieroglyphs, it is natural that neither he nor his followers could translate any entire hieroglyphic inscription without manifesting absurdities, as the Pompeian Tablet, in the premises, abundantly substantiates.

VII. Is it true, what Ch. taught, that the language of the ancient Egyptians was the modern Coptic, or else was it not rather a Hebrew dialect? Josephus calls the language, subject to the

Egyptian literature, ἱερὰ διάλεκτος, and, since the primitive names of the Noachian letters, preserved even in Greece and Italy, and the words expressed in the original alphabet were Hebrew, it is evident that the Egyptian language, spoken 3.000 years prior to modern Coptic, must have been a Hebrew dialect. This is another fundamental error of Ch., by which he and all his successors were prevented from translating Egyptian texts. This second part of the key to the Egyptian literature was discovered in 1826 (Rudimenta Hieroglyphices, Lips. 1826, p. 13), and confirmed and rectified in all the following researches (Alphabeta genuina, Leips. 1840; Grundsätze d. Mythol., Leips. 1843; Die Phœnix Period, Leips. 1848; Gram. Æg., Gotha, 1855; Theologische Schriften d. a. Ægypter, Leips. 1855, etc.) In the premises, pp. 269–76, 400 Coptic words are reduced to Hebrew roots, and so the half of our Coptic Dictionary will be referred to Hebrew and kindred words.

VIII. Is it true that Ch. has fixed the pronunciation of the phonetic hieroglyphs, or is it impossible to accomplish this task without previously making out the genuine names of the Egyptian hieroglyphs? The following is the way in which Ch. determined the alphabetic pronunciation of 201 hieroglyphs. Having clandestinely appropriated Young's first phonetic hieroglyphs, Ch., by means of them, deciphered a number of Roman and Greek proper names copied by the French savans accompanying Buonaparte in 1799. At the same time Ch. discovered that the phonetic hieroglyphs expressed the consonant or the vowel with which the name of the figure commenced, as is the case with the Hebrew letters. It is to be regretted that the Chts. forgot this rule, in consequence of which Brugsch, Lepsius, and so forth, did not fail wrongly to determine the phonetic values of so many hieroglyphs. Accordingly Ch. imagined that the same hieroglyphs expressed in older times the same letters which they seemed to express in Roman and Greek proper names; this was the fountain of gross mistakes. Suppose the name of some hieroglyphs to have been altered or corrupted in later times, what then? Thus it has turned out that of Ch's 201 phonetic hieroglyphs 88 were wrongly determined. In order to interpret ancient hieroglyphic texts, *it is necessary before all to mark out the ancient names of the 630 elements of the Egyptian literature.* See pp. 260–69.

IX. Has Ch's system been sanctioned or refuted by its fruits? Let us see some examples. The grammatical interpretation of the Pompeian Tablet brings to light that the great Cht. Brugsch could translate only two hieroglyphs, and that G's version of the same text, except the same two figures, contains downright nonsense from the first to the last word. Is it not ridiculous in the extreme that Italian cities and localities and names once existed like: Sechet, Samtati-taf-necht, Shatet-samtati, Afanch, Sechet, Essenem, Suten-senem, Uatur, Unnofer, Chnum?

In Ch's Gram., p. 294, we read that a passage of the T. B., which says that "a house existed in the valley, 30 cubits long, 15 cubits broad, and 4 cubits high," means a serpent of the same dimensions According to the same work, the mummy is the "non plus ultra of envelopes"; wherefore it must signify "cloth." A piece of meat, Ch. says, is a part of the whole, and consequently it signifies that "the son is a part of the paternal substance." See many other examples in my Gr. Æg. p. xxiii.

De Rougé's "Mémoire" informs that in Moses' time a fire-snake (habitans in igne suo), called "*Anhehu*," existed in Egypt.

In the same year, 1851, Brugsch's "Inscriptio Rosettana" appeared, which contains 700 words, but only 12 of them correctly translated by him. See Leipziger Repertorium, 1852, p. 364.

So far as the publications of the Cht. L. are concerned, we have already noticed (p. 277) that he could not translate a great deal of the T. S., that he misunderstood the most common groups, and procreated numberless monster-words occurring in no language of the world. It will be instructive to add a few examples from the T. S., explained by two Chts., Lepsius and Reinisch, for the purpose of proving that a system according to which the very same hieroglyphs and groups can be very differently spelled and translated, cannot be the key to the Egyptian literature.

L.	R.		L.	R.
suten	rus	*i. e.*,	king	king
aft	chub		both Egypts	both Egypts
machui	machura		Evergeta	Evergeta
mau	pauma		temples	temples
maret	hap		clothing	sanctuaries
toui	ruschub		Egypt	Egypt
suh	tur		time	time
tutu	churu		words	prayers
tua	sa		moved	since

L.	R.	L.	R.
er	sepur	*i.e.*, against	during
uta	wazu	prospering	condition
as	achu	much	great
ab	hutu	wishing	purpose
su	un	kinds	increase
ten	sahu	after the end	during
at	qam	moment	land
suhu	makanu	in times	in times
tut	churu	annunciation	for
tucha	tu	celebrated	?
en	kati	another	according
senen	tut	image	image
tamet	sa	man	man
tisbe	sab	teacher	master
uinim	hanabu	Greeks	Greeks
chunt	pauma	temple	temple

However, the masterpieces of Champollionistic interpretations of hieroglyphic texts are Brugsch's Geographic and Hieroglyphic Dictionaries. Relying upon his fixed idea that the map of the ancient earth, encompassed by the ocean, signifies ideologically "city," and that all groups preceded by the same map contain the names of cities, he created a thousand cities which never existed. But, alas, the said map commonly signifies the earth (ⲃⲓⲕⲓ, circuitus terræ), e.g. in the frequently occurring group eye, hill, earth (see Pl. xiii. No. 161; R. S. vi. 36; T. S. v. etc.), which signifies ϩⲟⲛⲧ ⲃⲓⲕⲓ, creator mundi. Moreover, the groups preceding the said map express the names of deities, and not of cities. Hence Brugsch's Geographical Dictionary is, with few exceptions, a deplorable failure. In consequence of this ignis fatuus poor G. built the new cities "Hebnu, Sah, Ahehu, Shat, Egypt, Suten-senen."

So far as B's Dictionary of four volumes in 4to, containing over 10,000 articles, is concerned, the writer is probably the only person in the world who was patient enough to examine it from the first to the last word, and he is able to prove that this pyramidal construction (price 560 frs.) contains scarcely one word of truth; at an average, of 100 articles scarcely one is true. This is — it will be objected—quite impossible, and yet it is true. Let us see.

1. B. knew not even the usual signs of plurality (Trans. of the St. Ls. Acad. Sci., vol. iv. 59); hence he took numberless substantives for verbs and adverbs, and plurals for singulars. The

sign of plurality, three kernels, signified ideologically, as he imagined, " metal"; and so he discovered many new metals, followed by the said kernels, whilst they only signify ονοτ, plurality.

2. Of Ch's phonetic hieroglyphs 88 were erroneous, as we have seen p. 284, and yet B., by means of these blunders, determined the signification of numerous groups, of course likewise erroneously.

3. Ch. maintained that all phonetic hieroglyphs express the initial, either vowel or consonant, with which the name of the figure commenced. B., on the contrary, determines the pronunciation of the hieroglyphs according to his fancy.

4. He also ascribes to several hieroglyphs, the pronunciation of which was already fixed by Ch., totally different sounds, as the following examples show. The pickaxe $m = b$, the coffer $s = a$, the sceptre, $k = nas$, the girdle $u = s$, the well-bucket $s = m$, the mast $t = n$, the scarabæus $t = ch$, the feather $m = s$, the hair $f = ha$, and so on.

5. It has been abundantly demonstrated that regularly each hieroglyph expresses syllabically the consonants contained in the name of the figure, which is the very simple key to the Egyptian literature. B., on the contrary, having forgotten this rule, determines the values of the figures according to the words which he conjured out.

6. Everyone taking this big Dictionary into his hands will certainly presume the same to be based on entire Egyptian texts grammatically explained. Quod non! Brugsch and all other Champollionists have never interpreted any hieroglyphic texts completely and logically; he has arbitrarily selected 10,000 hieroglyphic groups, which, being severed from the context of the Todtenbuch and many other monuments, admit a variety of translations. Thus the Hebrew letters *br* represent sixteen different notions or conceptions if severed from the context.

7. In order to bring out of his 10,000 hieroglyphic groups their respective meanings B. recurred to Ch's ideologic determinatives so as to judge to what class of objects the preceding group belonged. E.g., the group *hnt* followed by an amphora signifies "Lagerbier" (sic); and another Chst., Prof. Ebers, discovered that a gallon of "Lagerbier" was the dosis for a sick man. The letters *ib* terminated by an elephant signify " unguis," and so on.

Sometimes two, three and four determinatives were necessary for fixing the meaning of a group. *Ak* followed by two altars signifies stove. For expressing the word ⲟⲩⲱϥ, pulmo, the Egyptians added four determinatives, viz. clew, lion's claw, hill, track; and of the very same composition are several thousand of the articles to be found in this wonderful Dictionary, although B. was informed that the Egyptians never used ideologic hieroglyphs. Moreover, he discovered that the same word was determinated by very different appendices; e.g. the word "plantare" by a tooth, or a fence, or a horn, or two threshing-floors. B's sparrow is the determinative for the following conceptions, "dolor, percussit, nullus, puer, fallere," probably because they were altogether related with the sparrow. The same Cht. discovered that the determinatives stood sometimes in the midst of the groups. Besides, in case all these artifices were not sufficient in translating certain groups, B. had recourse to easier ones. He impressed upon the reader that many hieroglyphic groups contain mere expletive signs, *hieroglyphica quiescentia*, i.e. unutterable ones, e.g. the palm-tree, or he copulated the last letter of the preceding word with the following, or he altered the given consecution of the hieroglyphs, or he referred, notwithstanding the system of Ch., hieroglyphic groups to Hebrew roots, or he transformed hieroglyphic figures into new ones. B's Dictionary contains a great many of altered hieroglyphs. Now, if such proceedings are not foolishness and deception, no fool and cheat exists in the world.

8. Finally, what is to be done in order to put an end to the present Egyptian humbug, and to protect the public from further impositions of this kind? Remembering that since the publication of Ch's hieroglyphic system in 1824, based upon erroneous principles, a deluge of books following the very same principles has overflowed the scientific world; that the Chts. have introduced a totally wrong history of Egypt; that they, during a period of 57 years, have not yet furnished a grammatical exposition of one entire Egyptian text; that a polygrapher who is not at all, either morally or intellectually, qualified to promote this new department of ancient philology, whose works scarcely contain one word of truth, is the ignis fatuus which seduced the present generation into an abominable bog;—remembering these facts, I say, every honest man will long to see, finally, the truth triumph-

ing. But, how is this to be effetced? Shall we let the Chts. alone? Persons being deafened by the clapping of Ch's followers, and blinded by the nimbus put upon his head, will never confess the blunders of their master. On the contrary, they will propagate the fallacy by their new organ, "Revue Égyptologique, publiée par H. Brugsch, F. Chabas, et E. Revillout." Moreover, since the death of Prof. M. Uhlemann of Göttingen and H. Wultke no Egyptologist exists in Europe who is able and willing to swim against the stream. The Literary Gazettes, designated to warn against the propagation of literary falsehoods, do not exist any more. There is, under the present circumstances, only one way for reaching the end, and that is the following. The Champollionists must be foiced to confess the truth, and for this purpose they must, in all parts of the world, be attacked not with silk gloves, but with the fist of Clavigo, as follows.

CHALLENGE.

In the next place, I challenge Brugsch Bey, the first editor of the Pompeian Tablet, who since 1851 has constantly asserted "the great master Champollion to have discovered the key to the Egyptian literature," but the writer's researches to be "*vana ficta*," to translate and comment on the said text grammatically and logically, according to Champollion's theory, his Grammar and Dictionary, in the next numbers of his "Revue Égyptologique," or elsewhere. Should he, however, fail to accomplish the theme within six months, or to publicly confess his faults, I shall denounce him as a gross calumniator and shameless charlatan.

For the same purpose, and under the same conditions, I challenge Lepsius, who since 1836 has constantly maintained Ch's theory to be the key to the Egyptian literature, my own theory, on the contrary, to be the outcast of literary productions; further, the Rev. P. Le Page Renouf, a member of the Catholic University of Ireland, the most refined pasquillant among the greatest lampooners; furthermore, Prof. Ebers, in Leipzig, the pupil of Lepsius; likewise, the translators of Egyptian texts in "Records of the Past," published by the London Society of Biblical Archæology; especially, the blinded Champollionist C. W. Goodwin, M.A.; further, MM. F. Chabas and Eug. Revillout, the friends of Brugsch; finally, all other Champollionists, known or unknown to me,—to translate and interpret publicly the Pompeian Tablet, but strictly according to Ch's theory, his Grammar and Dictionary.—The latter, however, being already forgotten and totally altered by B., it will be necessary to add the following paragraph. At present everyone believes Ch's system to be represented by B.

PLAGIARISM.

1. In Ch's Précis, Grammaire, and Dictionnaire, we read that no hieroglyph expressed "one or two syllables" (see the passages in the writer's Gram. Æg. p. xvii.) This fundamental law has been deserted as well by L. and B. as by all later Egyptologists; they have clandestinely appropriated the writer's theory that "regularly each hieroglyphic figure expresses a consonantal syllable." Nobody before 1826 has discovered that the Egyptian literature was a syllabic writing. That conduct is termed plagiarism or literary theft.

2. According to Ch. the language of the hieroglyphs was the Coptic, and not the Hebrew, as the writer maintained. But B., deserting Ch's standard, clandestinely adopted the latter, and he referred some thousands of hieroglyphic words to Hebrew roots. Nobody before 1826 has taught that the *ἱερὰ διάλεκτος* was a Hebrew dialect. This is again plagiarism.

3 Ch. told the scientific world (see the passage in my G. Æ. p. xvii) that each of the phonetic hieroglyphs expressed only one sound, viz. that with which the name of the figure commenced, like the Hebrew letters. The writer, on the contrary, discovered in 1826 that the same hieroglyphs expressed sometimes very different letters, because the ancient names were changed in later times, the genders were discerned, etc. This rule was totally abandoned by the Chts.; they do not care any more about the names of the hieroglyphs and their initials. B. informs us, e.g., that the star expressed sometimes *s*, sometimes *b*, sometimes *t*. The acre signified *s*, *st*, *bs*, *k*; the child *s* and *k*; the statue *f* and *u*; the head *t*, *a*, *ap*, and *tp*; the tooth *a*, *m*, *h*; the phallus *t*, *m*, *met*, *boh*; the bee *k*, *af*, *sach*, *saket*; the eared-snake *o*, *e*, *i*, *h*, *fi*; and so on in many other cases. It is self-evident that in this way nearly all hieroglyphic groups can be spelled very differently and referred to ten different roots.

4. According to Ch. the Egyptians very often applied abbre-

viated words, e.g., *s* instead of *suten*, *o* for *onch*, etc. At present no Cht. recurs any more to Ch's abbreviations.

5. Ch. never asserted that the Egyptians appplied sometimes two, three, even four determinatives for one group; that the same used "quiescent hieroglyphs," and "put determinatives in the midst of the groups," as B. imposes upon his readers.

In spite of all these and many similar absurdities, and although Champollion knew not the real key to the Egyptian literature, that regularly each hieroglyph expresses syllabically the consonants contained in its name, and that the *ἱερὰ διάλεκτος* was a Hebrew dialect, and that ideologic hieroglyphs were unknown in Egypt; though he ignored the most common signs of plurality, of adjectives, participles, the pronouns, the suffixes occurring almost on each line;—in spite of all these facts, I say, B. has the sauciness to tell persons who possess only a literary knowledge of the matter, that "Master Ch. acquired the immortal merit of having discovered the key to the literature of the ancient Egyptians." Concerning this point, however, B. seems to have been not quite sure; for in the Preface, p. iii., he forbids criticism, and all researches concerning priority he calls in advance "disagreeable questions."

In short, once more we challenge B. and all the Chts. to translate and interpret the Pompeian stele according to Ch's true system, and not to its present transfiguration. Should he accomplish the theme in a satisfactory manner, then the strife is finished. Should he, however, refuse to accept the challenge, then he will remember that he is a responsible man, and that he is morally bound to repent of the immense injuries which he has done to science and truth during the last thirty-three years. Let him remember that "*honesty is the best policy.*"

In conclusion, it is now time to refute a new series of shameful calumnies originating at the residence of Ebers, a pupil of Lepsius and a clever novelist, and published in the New York "Staatszeitung," 1871, Nos. 77 & 82, and in the German journal "Daheim."

To wit, Ebers, whilst lecturing in Leipzig and other places, guilefully impressed upon his audiences that it was Champollion who discovered the key to the Egyptian literature. To this false insinuation, soon afterwards, Prof. H. Wultke, in Leipzig, a savant universally known for his valuable publications, remonstrated in another public lecture. In consequence of the latter the following deceptive statements appeared in the said N. Y. Staatszeitung.

1. The Tanis-stone demonstrates that Champollion's hieroglyphic system is the key to the Egyptian literature. Quod non! For Lepsius could not translate 440 hieroglyphic articles of this bilingual inscription. He misunderstood the most simple groups and brought out a mass of absurdities and monster words (p. 277). The translation of the same inscription made by Reinisch, following the same system, totally differs from Lepsius (p. 285). The afore-mentioned translation of the Pompeian Tablet, made according to Champollion, is the non plus ultra of nonsense. Nevertheless Evers has the effrontery to repeat that Champollion is "the great decipherer of the hieroglyphs," and the like, without mentioning that he never succeeded in translating the Rosetta-stone.

2. It is true that without assuming syllabic hieroglyphs it is impracticable to interpret entire hieroglyphic texts; but this discovery was made not by Champollion or Lepsius, as Ebers insinuates, but by another. It is a fraud that Champollion in his "Grammar" (1832) or Lepsius in his "Lettre à Rosellini" (1837) first of all discovered syllabic hieroglyphs; for in 1824, whilst paralleling the different copies of the sacred Egyptian Records with each other and word for word, at Berlin, the writer discovered that the Egyptians sometimes expressed the sparrow-hawk by the letters *kr*, and this fact demonstrates that the former syllabically expressed the letters *kr*. The writer's "Rudimenta Hieroglyphices" (1826, p. 25, § 16) clearly distinguishes alphabetic and syllabic hieroglyphs, and in the same work the first 12 syllabic glyphs were produced. The reason why the Egyptians expressed two consonants by one image, it is true, was then erroneously explained; but afterwards in 1844 (Leipziger Repertorium, Aug. 8; Verhandlungen der ersten Versamlung Deut. Orientalisten, 1845, p. 65) it came to light that regularly each hieroglyphic image signified the two or three consonants contained in the name of the figure. See the writer's G.Æ. p. xxxii. Nobody before 1826 & 1833 (Ast.Æg.) had discovered the syllabic signification of the hieroglyphs, and yet Ebers does not hesitate to say that Lepsius discovered the first syllabic hieroglyphs in

1837. Moreover, the latter has never discovered that the syllabic glyphs expressed the consonants contained in the name of the figure ; his theory was the following. In earlier times the Egyptians expressed some words of their spoken language by two alphabetic characters, but afterwards they dropped the second sign, and hence the remaining first obtained syllabic value. This theory is as foolish as the writer's first idea concerning the syllabic values of the hieroglyphs. So far as the assertion is concerned that Champollion discovered the first syllabic glyphs in 1832, I do not know whether the year 1832 precedes 1826 or vice versa. Moreover, in the same aforesaid articles Ebers informs his readers, both that Champollion discovered the first syllabic hieroglyphs, and that Lepsius discovered the same "denied by Champollion." I do not venture to decide in what place Ebers told the truth, and where he asserted the reverse of truth. Nevertheless great Ebers impresses upon his faithful readers that S. (the writer) has stolen Champollion's or Lepsius's discovery I wonder that a Professor of the University of Leipzig did not blush in uttering such a defamation.

3. The same Champollionist maintains that "the great master's theory" is put beyond question by numberless translations. This is another cheat ; for translations of Egyptian texts without commentaries, without reducing every word to reliable roots and grammatical certainties, prove nothing. For instance, Kircher translated all the Roman obelisks, and yet at the present time all the Egyptologists know that Kircher's seven volumes in folio do not contain one word of truth. Goodwin's translation of the Pompeian slab contains, as we have seen, only four words correctly explained. Birch's version of the Todtenbuch, to which Ebers had recourse, decides nothing as long as a grammatical commentary is not added. Lepsius's and Reinisch's translations of the Tanis-stone totally differ from each other ; their commentaries, promised eleven years ago, are still to be expected. All the translations of Egyptian texts in "Records of the Past," in French journals, even in Ebers' translations of his medical papyrus, wherein he took "Lagerbier" for a medicine and "honey" for a medical plant, prove nothing in favor of Champollion's theory. The latter being the true key to the Egyptian literature, how came it to pass that the great author of an Egyptian Dictionary

of 10,000 articles, and an extensive Grammar, could not, with the exception of two words, translate the Pompeian Tablet?

4. By means of S.'s (the writer's) system, says our Œdipus, "not one-half of a hieroglyphic line can be translated." This ingenuous declaration clearly proves that he has never seen the writer's Egyptian Grammar, Theologische Schriften, and other publications. The former (p. 51–81) elucidates eleven chapters of the Todtenbuch, and each group is spelled out, reduced to Coptic and Hebrew roots, and accordingly translated. The second work contains, 1. a commentary to the entire first book of the same sacred Egyptian records; 2. to the Judgment of the Dead; 3. to the Hymn to Orion; 4. to the Princes in the land of justice; 5. to the Creator of the fruits; 6. to the Heavenly Household; 7. to the Hymn to the Sun; 8. to the Catacomb of Amos; 9. to Idolum Thordanum; 10. to the Sarcophagus of Memphis; 11. to the Sarcophagus in the Academical Museum of Leipzig; 12. to the Door of Philæ; 13. to the Rosetta-stone; 14. to Hermapion's Obelisk; 15. to the Tablet of Abydos,—apart from the translations in "Zeitschrift der Deutsch. Morgenl. Gesell." etc. Now, is it true that it is "impossible to read only one-half of a hieroglypic line" by means of the writer's theory?

5. The same veracious friend tells the world that S. (the writer) "could only translate by the instrumentality of a self-made language, called by him Old Chaldaic." Will the reader be so kind as to examine one of those translations? In case the language of the ancient Egyptians was not related with the Hebrew, the primitive tongue of the world, Brugsch was a fool in reducing a thousand hieroglyphic words to Hebrew roots, as his Dictionary shows.

6. Further, it is an imposition that Lepsius has fixed "forever" the history and chronology of Egypt; for the historical and astronomical monuments of the Egyptians demonstrate that their history commenced in 2780 B.C., and not before the deluge and the creation. Lepsius's "Chronology," "The Book of the Kings," and the like, are deplorable *ignes fatui*.

7. It is an illusion that "Lepsius discovered the cycles of the solar deities," for the respective representations involve planetary configurations.

8. It is falsity that Lepsius discovered the standard alphabet of

the Egyptians; for his 46 primitive letters were not discovered, but arbitrarily congested. The genuine alphabet of 25 letters is the basis of the Egyptian literature, which was totally strange to Lepsius.

9. It is untrue that Lepsius's hieroglyphic types are an immortal merit; for a great many of them, cut according to the author's fancy, differ from the originals, and therefore they are useless. The same, moreover, do not run, as Herodotus says, from the right to the left hand, but vice versa. Accordingly it would be necessary to establish hieratic and demotic types equally wrong.

10. It is a deception that Lepsius discovered the Tanis-stone; for this honor belongs to an association of four persons—Lepsius, Weidenbach, Reinisch, and Roesler—while the first was absent.

11. It is a shameful fraud that "Champollion's system has vanquished its antagonists and now reigns." For all the Champollionists have secretly forsaken "the orthodox theory." They disregard the rule that every hieroglyphic inscription consisted "half of phonetic, half of ideologic figures"; they abandon the theorem that no hieglyph "signifies a syllable"; they give up the chimera that no hieroglyph "expressed different sounds"; they relinquish the prejudice that the language of the ancient Egyptians was the modern Coptic, not related with the Hebrew. All these facts had been previously discovered by the writer, but were clandestinely appropriated by the Champollionists. Hence the system which rules at present is that of the writer, and not Champollion's.

The only truth contained in these remarkable lampoons and pasquinades is that S.'s (the writer's) "merits are very narrow ones." Yet I disclaim any merit at all in this affair, because I have never longed for merits or laurels. I confess, moreover· that I was never able to compose Egyptian romances.

However, the question, What is the true hieroglyphic system? being important in the revival of ancient Egypt, I challenge the Champollionist Ebers to publish within the next six months a grammatical translation and interpretation of the Pompeian Tablet according to Champollion's true system. Should he refuse to accept this challenge, then I shall call him a shameless calumniator.

Notes on North American Microgasters, *with descriptions of New Species.*

By C. V. Riley, M.A., Ph.D.

[Read Feb. 7, 1881.]

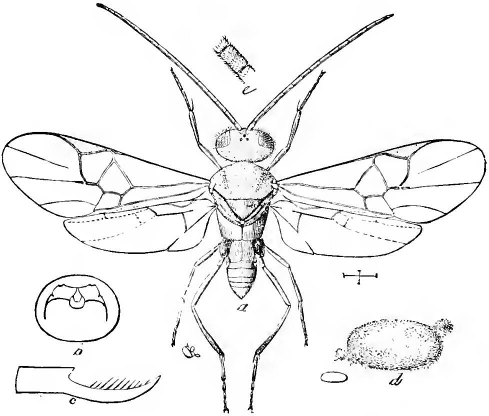


Fig. 1.—Apanteles aletiæ: *a*, female fly; *b*, outline of head of larva in position to show the chitinized parts of the mouth, the mandibles not visible, being withdrawn; *c*, one of its mandibles as seen within the head of a mounted specimen; *d*, cocoon; *e*, joint of antenna—all enlarged: nat. size of *a* and *d* in hair-line. (Riley, del.)

The insects of this group are among the most common parasites of the various caterpillars injurious to vegetation. They are, therefore, among the more important of the farmer's insect friends. Yet they have hitherto been but little studied in this country; for, aside from the eight species described by Say, we have only one species described by Fitch, one by Walsh, one by Packard, two by myself, and two Texan species by Cresson, while notices of the habits of only a few of these have been published. I have during the past fifteen years, in rearing Lepidoptera, obtained quite a number of species, some of which have been sent to Dr. A. S. Packard, Jr., of Providence, R. I., but most of which have been referred to Mr. E. T. Cresson of Philadelphia. Dr. Packard proposes shortly to describe several species, and more particularly those affecting butterfly larvæ, while Mr. Cresson is at the present time working up the group. It is with a view of assisting in this work that I have been led to prepare these notes and to describe the few species which more particularly interest me. My thanks are due to Messrs. McCalla & Stavely for the loan of figures 6 and 7, and to Mr. W. H. Patton for assistance.

CHARACTERISTICS OF THE GROUP.

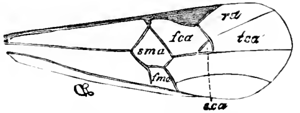


Fig. 2.—Front wing of Microgaster gelechiæ, enlarged; *fma*, first median area; *sma*, second do.; *fca*, first cubital area; *sca*, second do., or "the areolet"; *tca*, third do.; *ra*, radial area.

The Microgasters are distinguished from the other members of the family Ichneumonidæ by their hairy eyes and 18-jointed antennæ. The second cubital areolet of the wings in the majority of the species is not closed externally (Fig. 1), but when complete (Fig. 2, *sca*) this areolet is quite small. The radial area (Fig. 2, *ra*) of the wings is never complete, and that portion of the radial vein extending from the stigma to the second cubital areolet is the only portion of the vein that is distinctly marked, this portion together with the basal vein of the second cubital areolet forming what has been described by some authors as the "outer side" of the first cubital areolet. The ovipositor is generally short, not extending beyond the tip of the abdomen; but in a number of species it is exserted, as in *Microgaster gelechiæ*, where it is one-half the length of the abdomen; and sometimes it is equal to the whole abdomen in length, as in *Apanteles megathymi*. The body is generally black, the legs pale, and the wings transparent with a dark stigma; the abdomen is sometimes marked or banded with red. the antennæ vary from black to red, and the palpi are whitish or reddish. The thorax is more or less densely punctate and the basal joints of the abdomen afford good characters in the presence or absence of sculpture. The size varies greatly in different species, but none equal one-fourth of an inch in length and the majority do not exceed one-eighth.

Foerster, in his "Synopsis der Familien und Gattungen der Braconen," published in 1862, separated two genera from the old genus Microgaster, and H. Reinhard, in the "Deutsche Entomologische Zeitschrift" for 1880, p. 353, shows that these genera are well founded. They may be distinguished by the following characters:

MICROPLITIS Fr., 3 cubital cells: 2d and 3d abdominal joints confluent. Ovipositor concealed. Posterior coxæ not large: spurs of posterior tibiæ less than half the length of the first tarsal joint. Mesopleura with a punctured groove. Cocoons leathery, without loose silk.

MICROGASTER Latr., 3 cubital cells: 2d and 3d abdominal joints distinctly separated. Ovipositor exserted. Posterior coxæ unusually large: spurs of posterior tibiæ more than one-half the length of the first tarsal joint. Cocoons white and with loose silk.

APANTELES Fr., 2 cubital cells: 2d and 3d abdominal joints separated. Ovipositor long or short. Mesopleura with no distinct groove. Cocoons with loose silk.

HABITS OF THE GROUP.

The Microgasters are, with few if any exceptions,* confined in their attacks to the larvæ of Lepidoptera. The Microgaster larvæ that I have observed are all apodous grubs, of which that of *Apanteles aletiæ* may serve as an example.

A. ALETIÆ. *Larva.*—4 mm. in length. A smooth, memberless grub, narrowing towards the head and thickest near the posterior end; the head nearly as large as the 1st joint, the sutures between the joints rather indistinct. The mouth parts (Fig. 1, *b*) minute, similar to those of other hymenopterous parasites. The 6th, 7th, 8th and 9th joints behind the head provided with a pair of prominent lateral tubercles; pairs of slighter tubercles on the 5th and 10th joints. Color white, or tinged with green or yellow.

They always emerge from their host before it attains the pupa state to spin their cocoons. Sometimes but a single larva of the Microgaster is nourished by the caterpillar, although in most cases many feed in company, and, emerging at the same time,

* Reinhard (l. c.) gives a list of the exceptions, there being 4 cases of parasitism on Beetles, 2 on Saw-flies, 1 on a Gall-fly, all recorded by Ratzeburg; a case of parasitism on a Gall fly observed by Mayr; one on a Fly by Haliday and another by Bouché, and two species bred from *Cecidomyia rosaria*, one by Ratzeburg and one by Mayr. But, as all these species have also been bred from Lepidopterous larvæ, Reinhard considers that these comparatively few observations are of questionable accuracy. Still another case of parasitism upon Diptera (*M. obscurus* Nees upon *Trypeta arnicæ*) is mentioned by Giraud and Laboulbène in the "Annales de la Société entomologique de France" for 1877, p. 413; and mention is there also made of the parasitism of *M. gallicolus* upon *Arthrolysis Guyoni*, a Chalcid, in the galls made by a moth, *Œcocecis Guyonella*, on Limonastrum. But no particulars are given regarding the parasitism upon *Trypeta*; and a reference to the original description (Ann. Soc. ent. Fr., 1869, p. 476) shows that it was upon the moth larva that the *M. gallicolus* fed. I find in my notes the record of a species reared from the larva of what may have been *Odontota rubra*, but possibly some Lepidopterous larva was mining the same leaves.

spin their cocoons more or less closely connected together, sometimes to the number of several hundred. In the "Proceedings of the Entomological Society of London" for 1872, p. xxiii., Prof. Westwood notes an instance in which 1,000 individuals were bred from one larva of a large Ceylonese Bombycid.

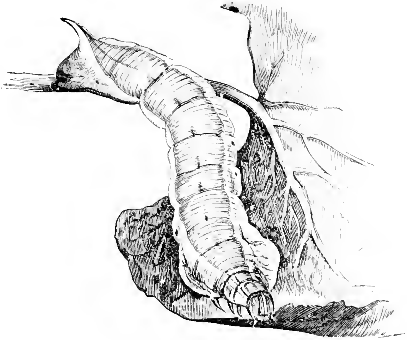


Fig. 3. Healthy larva of Chærocampa pampinatrix. (After Riley.)

The victimized caterpillar ceases feeding as the parasitic grubs attain full growth, and generally shrinks considerably as soon as they have penetrated the skin and spun their cocoons. Fig. 3 shows a healthy full grown "Hog-caterpillar of the Vine" (*Chærocampa pampinatrix*), and Fig. 4 the same caterpillar when shrunken and parasitized.

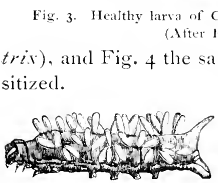


Fig. 4.—Shrunken larva of Chærocampa pampinatrix, with Microgaster cocoons. (After Riley.)

"It is one of those remarkable and not easily explained facts, which often confront the student of Nature, that, while one of these Hog-caterpillars in its normal and healthy condition may be starved to death in two or three days, another, that is writhing with its body full of parasites, will live without food for as many weeks. Indeed, I have known one to rest for three weeks without food in a semi-paralyzed condition, and, after the parasitic flies had all escaped from their cocoons, it would rouse itself and make a desperate effort to regain strength by nibbling at a leaf which was offered to it." *

The cocoons are usually egg-shaped and resemble miniature cocoons of the Mulberry Silk-worm. They are either smooth and glossy, or more or less covered with flocculent silk. When

* Second Report on the Insects of Mo. 1869. p. 73.

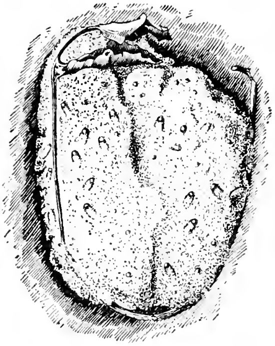


Fig. 5. — Mass of Microgaster cocoons with rib of a leaf drawn around them.

spun in association they are held together by this loose silk either irregularly, or in regular single row or double row, and the loose silk may be so abundant as to look like matted masses of cotton or wool, and to almost or entirely hide the individual cocoons (Fig. 5). Exceptionally the texture of the cocoon is leathery and the surface ribbed, while in a few cases the sides are flattened. In the case of *Apanteles acronyctæ* no definite cocoon is formed, but the larvæ transform promiscuously in a mass of silk. In color there is every variation through silvery-white, dull opake white, cream-color and different shades of yellow to brown.

The peculiar manner in which the Microgasters infesting Philampelus spin their smooth cocoons has been described in the "American Naturalist" for 1878, vol. xii. pp. 558–60. Mr. J. P. Marshall, describing the species parasitic upon Philampelus,

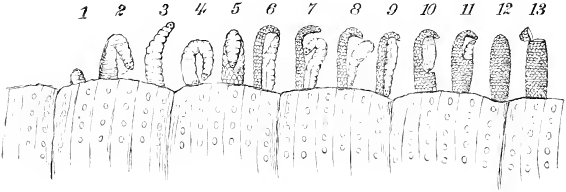


Fig. 6.—Formation of smooth cocoon by the larva of Microgaster. (After Marshall.)

states that the first act of the Microgaster upon emerging from the caterpillar is to attach its posterior end to its host by some silken threads, as shown in Fig. 6, [4]. It then forms a series of loops of silk, as shown greatly enlarged in Fig. 7, moving its head alternately from left to right and then from right to left. After spinning to the top of the cocoon (Fig. 6, [6]) the larva reverses its position so as to rest with its head down (Fig. 6, [9]), when it spins the other side of its cocoon, gradually contracting its body as the work proceeds; and finally, to complete the enclosure of the cocoon, again reversing its position so as to appear in the attitude shown in Fig. 6, [11]. Mr. Wm. A. Buckhout (ibid. p. 752) notes several points of difference in the formation of similar cocoons by the species infesting Macrosila. This Microgaster, after completing one-half of its cocoon and reversing its position, flexes its body so as to bring its head back to the top of the cocoon, "from which it spins downwards till the back of its host is reached and it is entirely enclosed," the spinning of the two halves of the cocoon being upon practically the same plan, the first half being spun from below upwards, the second from above downwards. In lining the cocoon the larva repeatedly changes its position.

In the case of *Apanteles aletiæ*, which spins its cocoon not in a perpendicular position as do those on the Sphinges, but recumbent upon the cotton-leaf, the outer covering being somewhat more loose and "fuzzy," Mr. H. G. Hubbard, in a recent report to me, describes the process as follows. "In quitting its host the parasite maintains its connection therewith by means of a single thread. After crawling to a distance of about half an inch, it fastens this thread to the surface of the leaf and begins its cocoon. The larva forms the exterior by throwing out loops of ropy fluid, which under the lens are seen to become rigid as they fall, and to harden rapidly, forming a rather coarse strand of white silk, which is often beautifully furred. These loops are piled one upon another, and the walls of the cocoon rise rapidly until they meet overhead. The inside is then lined in the manner usual with Lepidopterous larvæ, until the whole has become opake. The process of spinning occupies about two hours' time."

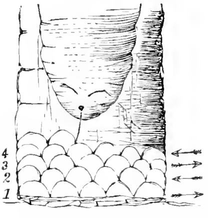


Fig. 7.—Commencement of cocoon by larva of Microgaster. (After Marshall.)

It is in this as in almost every other genus or group, very difficult to separate species, so called, when a large number of individuals or abundant material is studied. Some of the forms indicated as good species by entomologists, especially if descriptions were based upon one or two individuals without reference to the variation that occurs, are sure to prove to be only varieties. It is quite natural to infer that differences in the host, especially when associated with difference in the cocoon, would indicate specific difference. But the result of my study shows very clearly that there may be great variation in the characters of the cocoon, and that these are of little value in distinguishing species. Indeed the color, form, texture and arrangement of the cocoons varies greatly not only in the different species, but sometimes in the same species. The same species of caterpillar also often suffers from the attacks of several species of Microgasters, as is the case with the Army-worm; and, conversely, one species of Microgaster often attacks a variety of caterpillars, and in this case the species sometimes presents slight variation in its characters when attacking different hosts. This variation may be considered entomophagic, and when sufficiently marked should be indicated by a variety name, as I have done below in treating of *Apanteles congregatus*. The species *Apanteles cassianus* bred from *Terias nicippe* shows a peculiar variation in the cocoon and also in the time required to perfect the imago. Its cocoons are either yellowish, ovoid, and quite woolly; or brown, four-sided, and without loose silk. Cocoons of the two forms found with the Terias on *Cassia marylandica* Sept. 10, 1874, gave forth flies on Oct. 1st following and on Aug. 4th, 1875, the former from the ovate cocoons, the latter from the other form of cocoon, and the flies are indistinguishable.

From the cocoons of Microgasters are often bred secondary parasites. The most common of these are either Ichneumonids of the genera *Hemiteles* and *Mesochorus*, or Chalcids allied to *Pteromalus*. The *Hemiteles cressonii* bred by me from the galls of *Gelechia gallæsolidaginis* is probably a parasite of the *Microgaster* which attacks the maker of the galls. *Mesochorus vitreus* Walsh, which was described as a parasite of the Army-worm (*Leucania unipuncta*), I have bred from the Microgasters truly parasitic on that pest. The Chalcid, *Glyphe viridescens* Walsh, which was bred by Walsh from *Apanteles militaris*, and by Fitch (who, in his 9th Report, described it as new under the name *Pteromalus tabacum*) from *Apanteles congregatus* when parasitic on the Tobacco-worm (*Macrosila quinque-maculata*), I have bred from the last named Apanteles when parasitic on the Army-worm.

DESCRIPTIONS OF NEW SPECIES.

MICROPLITIS CERATOMIÆ, n. sp.—Length 2.5 mm. ♂♀. Black; antennæ, labrum and mandibles piceous, palpi whitish; legs red, the coxæ (except at apex). the basal joint of posterior tarsi and all the claws blackish; tegulæ and base of costa testaceous, wings subhyaline, the stigma entirely and the veins piceous. Antennæ longer than the body in both sexes, joints 3–17, constricted in the middle so that each might easily be counted as two joints. Mesothorax confluently punctured, a slight median ridge posteriorly, a deeply impresssed groove each side, these grooves slightly approaching posteriorly. Metathorax coarsely reticulated, with a prominent median ridge. Abdomen much shorter than the thorax, ovate, basal segment vertical, finely punctured, second and following segments shining, not punctured, the second segment without oblique grooves. Radial vein arising from the middle of stigma, stout, forming a right angle with the basal nervure of the quadrate areolet and also forming one side of the areolet, beyond the areolet it is slender, a white spot on cubital vein at base of areolet, the vein closing areolet exteriorly also white, the side of stigma bordering the first cubital cell swollen, that bordering radial cell straight, apical nervures of the wing slender but distinct.

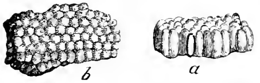


Fig. 8.—Cocoons of Microplitis ceratomiæ; *a*, side view; *b*, top view (after Riley).

Described from many specimens which issued March 6th from cocoons formed, in September of the previous year, by larvæ found, in Missouri, emerging from the caterpillar of *Ceratomia quadricornis*. The cocoons, formed in irregular masses of from four to twenty together, are of a brown color, thick, tough, coarsely ribbed longitudinally, and without loose threads.

The mass of cocoons originally figured in the second volume of the *American Entomologist*, p. 128 (see Fig. 8) and which was received from Mr. G. C. Brackett. Lawrence, Kans., differs from those above described in the cocoons being spun regularly side by side and lacking the ribs. The flies from these cocoons differ only in the slightly greater size, reaching 3 mm. in length. To these large specimens Mr. Cresson has given the MS. name *actuosus*. The same large variety, together with the compact cocoons, also from *C. quadricornis*, I have received from Mr. A. J. Randall, Aviston, Ill. It may be that this is the species bred from *Macrosila 5-maculata* by Mr. Emerton and figured in the Ninth Ann. Report of Dr. Hayden's Survey, p. 781, fig. 48, although the cocoon there figured is solitary.

MICROPLITIS GORTYNÆ, n. sp. — Length 2 mm. ♂♀. Black; mandibles, labrum, palpi and antennæ, the tegulæ, nervures and stigma testaceous; the apical joints of palpi and the base of stigma whitish; legs red; the posterior coxæ black; wings hyaline. Antennæ of the female a little longer than the thorax and the joints no longer than broad; antennæ of the male longer than the body, most of the joints twice as long as broad. Mesothorax punctured, opake, lateral grooves not sharply defined; metathorax reticulated, with a median carina on its upper face. Abdomen smooth and shining, base of first segment finely punctured, the broad lateral margins of the first segment and the lateral anterior angles of the second of a softer texture and tinged with piceous. Ovipositor not exserted. Venation as in *ceratomiæ*, but the areolet without any distinct side upon the radius.

Described from nine specimens bred from cocoons sent from Iowa by Dr. A. W. Hoffmeister. Parasitic upon *Gortyna* (*Achatodes*) *zeæ* Harr. The cocoons are light reddish-brown and have about a dozen longitudinal ribs of a white color, and are firmly attached together in irregular masses. I have found similar cocoons, more regularly arranged, beneath the bark of a sycamore near the root.

Specimens (1 ♂, 5 ♀) bred in January and February, 1874, from *Hepialus humuli* received the previous autumn from Mr. O. M. Knox, Oneida Co., N. Y., appear to belong to this species, although some of them vary in having darker legs and antennæ, in the stigma being of a uniform color, and in the areolet being quadrate. This species is quite distinct from *ceratomiæ* in having the antennæ of the female short.

In the genus *Microplitis* it is often difficult to decide whether the areolet is open or closed, as the exterior vein is white or transparent. In *Apanteles* this vein is entirely wanting and in *Microgaster* it is as strongly marked as any of the other veins. In this respect, therefore, *Microplitis* stands between the other genera; but in all its other characters, excepting the enlarged coxæ, *Microgaster* occupies the intermediate position.

APANTELES MEGATHYMI, n. sp.—Length of body 3 mm. ♂♀. Black; palpi whitish, antennæ piceous; legs red, the coxæ, and in the males the posterior femora and tarsi and the tips of the posterior tibiæ, black or piceous, in the females the tips of posterior tibiæ and the posterior tarsi dusky; wings, including the *stigma, hyaline;* tegulæ and nervures white, the costa and the outline of the stigma testaceous. Mesonotum closely punctate, the punctures tending to unite to form striæ, opake, the scutellum polished, sparsely punctate; metathorax finely reticulate, divided into larger areas by regular ridges, two of these ridges enclosing a median ovate-lanceolate area, there being no median carina. Abdomen as long as the thorax, narrowing towards base; basal joint, excluding the less chitinized sides, longer than broad, and longer than the second and third joints taken together, delicately sculptured and with some scattered punctures of larger size; remainder of the abdomen smooth; second joint very short, separated from the third by a deep, but very narrow groove; the third joint twice as long as the second. The ovipositor exserted and as long as the abdomen. The vein from the stigma forms with the basal vein of the areolet only a slight curve.

Described from many specimens bred from larvæ of *Megathymus yuccæ* received from South Carolina. The cocoons are spun in white masses, filling the silk-lined burrows of the Yucca-Borer. The flies appear in April shortly after the time of appearance of the butterfly, and are more or less powdered with the waxy secretion of the caterpillar.

The long ovipositor must be of service in enabling this species to attack its host through the lining of the burrow; and it is worthy of note that a smaller species (*Ap. carpatus* Say) which I have bred, in Illinois, from the larval-cases of the Carpet-moth (*Tinea tapetzella* L.) likewise has an ovipositor as long as the abdomen, and that *M. gelechiæ*, which must pierce the walls of the gall inhabited by its host, also has an exserted ovipositor, as have also an *Apanteles* bred from the larva of *Gelechia cercerisella* Cham., which folds the leaf of *Cercis canadensis*, and the following species bred from the larva of *Cacœcia semiferana* (Walk.) which folds the leaf of the Box-elder (*Negundo aceroides*). A group of small species parasitic upon leaf-miners also have a slightly exserted ovipositor.

Apanteles cacœciæ, n. sp.—Length of body 2 mm. ♂♀. Black; palpi whitish, tip of mandibles sometimes testaceous, antennæ piceous; legs black, the anterior pair from middle of femora and the basal half of posterior tibiæ testaceous; wings hyaline, stigma piceous, nervures testaceous. Antennæ of female as long as the body, of male longer than the body. Mesonotum shining, the punctures shallow; metathorax and two basal joints of abdomen with larger, very shallow punctures; remainder of abdomen smooth. Abdomen as long as the thorax; basal joint, excluding the less chitinized sides, longer than broad and longer than the second and third joints taken together; second joint very short, being only half the length of the third. Ovipositor exserted and as long as the abdomen. The vein from the stigma forms a strong curve with the basal vein of the areolet and an angle is sometimes present at their point of union.

Described from nine specimens bred in Missouri, June 21, 1876, from *Cacœcia semiferana* (Walk.) The delicate white cocoons are spun together in a roll of a leaf. From *Apanteles carpatus* (Say) this species differs in its smaller size, shining thorax, and smooth metathorax and abdomen. *Microgaster clavatus* Prov. appears to be a synonym of *carpatus*, although Provancher's description is faulty in making no mention of sculpture. Among a dozen *carpatus* bred in July I find some variation in the color of the legs, in four of the specimens the legs being more or less tinged with piceous.

Apanteles aletiæ, n. sp. (Fig. 1, *a*).—Length 2 mm. ♂♀. Black; palpi white, labrum, mandibles and basal joint of antennæ piceo-testaceous, the flagellum sometimes piceous. Legs light red, the posterior tibiæ whitish on the basal half; tips of posterior tibiæ, the posterior coxæ and tarsi, black or blackish; the posterior femora sometimes dusky. Abdomen testaceous beneath, except along the median line and on the apical third; the edges of the first joint testaceous. Wings hyaline, the tegulæ, veins and *stigma white*. Mesoscutum closely punctured, opake; scutellum sparsely punctured; metathorax obliquely truncate, its posterior face with a median subtrapezoidal or pentagonal area. Abdomen narrow, basal joint as long as one-half of the remainder, rugose, its posterior border excavated in the middle, remaining joints not sculptured and not highly polished. Ovipositor not exserted. Radial vein arising slightly beyond middle of stigma and forming a curve with the basal vein of the areolet. This species resembles *Ap. hyalinus* Cress., described from Cuba, but differs in the coloration of the legs and in the ovipositor not being thickened at the tip.

Described from many specimens bred from the young larva of *Aletia argillacea*, in Florida, by Mr. H. G. Hubbard, and in Alabama by Mr. E. A. Schwarz and Mr. W. H. Patton. There are several generations during the season, as it has been bred in August, September and October from the different broods of the Cotton-worm. The fly is disclosed about ten days after the cocoon is formed. Mr. Schwarz observed that the larva of this Microgaster is found only in the posterior part of the Aletia larva. It is a solitary parasite, only one specimen infesting a single Cotton-worm. The cocoon is formed, without concealment, upon the cotton-leaf, and was found quite commonly the past season, although it had not been observed before. It measures from 3 to 4 mm. in length, is of a white color, and is covered with loose silk, this outer covering forming two characteristic tufts at opposite ends of the cocoon and on opposite sides. The fly emerges through a lid-covered opening which it cuts for itself at one end of the cocoon, as is the habit of other species of the genus. Mr. Hubbard has bred from the cocoons of this species a secondary parasite belonging to the Chalcids and Mr. Schwarz has similarly bred a *Hemiteles*.

Apanteles politus, n. sp. — Length 1.8 mm. ♂♀. Pitchy-black; mandibles, palpi and basal joint of antennæ testaceous; flagellum beneath on basal half piceo-testaceous; legs honey-yellow, the coxæ, and in the posterior legs the tarsi, the apical half of the tibiæ and the tips of the femora piceo-testaceous; wings hyaline, nervures and stigma testaceous; first and second joints of abdomen beneath and their sides broadly above testaceous. Antennæ of female shorter than body, of male a little longer than body. Mesothorax smooth and polished; metathorax depressed, smooth and polished, its upper face limited by a carina on each side. Abdomen smooth; the central portion of basal joint very narrow. twice as long as broad, narrowing behind to meet the triangular central area of the second joint; the second joint with very broad membranose sides separated by deep oblique grooves, this joint only half as long as the first joint. Ovipositor concealed. Radial vein forming an angle of 120° with the basal vein of the areolet.

Described from many specimens bred, in Missouri, from *Scolecocampa ligni* Guen. The cocoons are spun in an irregular, flattened mass beneath the bark, and are of a dirty-white color. In the form and sculpture of the abdomen and in venation this species agrees with *militaris*, but it differs in the smooth thorax and dark posterior coxæ.

Apanteles cassianus, n. sp. — Length 1.5 to 2.2 mm. ♂♀. Black; palpi white; mandibles sometimes testaceous; knees, the four anterior tibiæ, the basal half of posterior tibiæ, and all the tarsi excepting at the apex and on the apical half of the basal joint of posterior pair, whitish; the anterior femora more or less piceous and the intermediate tibiæ often tinged with testaceous. Wings hyaline, the veins white; the stigma, strongly in contrast, piceous; tegulæ tipped with piceous. Antennæ of the ♀ scarcely shorter than those of the ♂. Mesothorax opake, the punctures shallow and obscure; metathorax opake, without distinct sculpture, its upper face limited on each side by a carina exterior to the spiracles; a few slight ridges at the apex. Abdomen without punctures, lateral margins of the basal joint dark piceous, the central portion broad and with sharply defined sides; second joint with a broad, triangular central area marked off by two deep grooves which diverge from the middle of the anterior margin; ovipositor concealed. The radius forms with the basal vein of the areolet only a slight curve, but in one or two specimens there is a slight angle on the outer side at their point of union.

Described from twelve specimens bred, as mentioned above (p. 302), from cocoons found, at East St. Louis, Ill., upon *Cassia marylandica* with *Terias nicippe.*

APANTELES THECLÆ, n. sp.—Length 2 mm. ♂♀. Black; palpi white; labrum, mandibles, and sometimes the antennæ, piceous; tibiæ and tarsi testaceous, the apical half of posterior tibiæ and the posterior tarsi blackish. Wings hyaline; the tegulæ, stigma, costa beyond stigma, and the radius and veins at base of areolet, piceous. Antennæ of the female much shorter than the body, of the male nearly as long as the body. Mesothorax closely punctured, opake; metathorax not truncate, finely rugose-reticulate and with a slight median longitudinal ridge. Two basal joints of the abdomen with numerous distinct punctures, remaining joints often sparsely punctate; basal joint with the lateral margins narrow; ovipositor not exserted. Stigma short, triangular, radius descending from its middle and uniting at a considerable angle with the basal vein of the areolet.

Bred Sept. 26, 1878, from larvæ which emerged Sept. 18th from a larva of a species of Thecla found feeding upon cotton plants at Augusta, Ga. Also bred by Mr. E. A. Schwarz at Selma, Ala., Sept. 16, 1880, from cocoons spun Sept. 6th. Also bred from a larva of the same Thecla received from Mr. B. F. Cooke, Marion, Ala., July, 1880. The cocoons are white and are spun together in irregular masses, as many as twenty of the parasitic larvæ being sometimes found to infest a single caterpillar of the Thecla. *Ap. limenitidis* closely resembles this species, but it is larger, the basal joints of its abdomen are densely rugose, and its cocoon is yellowish and solitary. The three specimens bred from *Gelechia gallæsolidaginis* which I mentioned as a variety in the original description of *limenitidis* prove upon further examination to be males and to belong to a distinct species, the basal joints of the abdomen being quite smooth.

APANTELES LIMENITIDIS. *form* FLAVICONCHÆ.—Under the above name may be recorded a species or variety which is found in Connecticut as well as in Missouri, and which presents all the characters of the species bred from the young larvæ of *Limenitis disippus*, but which spins its cocoons in masses like those of *M. militaris*, with which it is associated in fields infested with the Army-worm. The cocoons also are of a bright lemon-yellow, those of the true *limenitidis* being dull yellow. From *congregatus* the imago of *flaviconchæ* differs in the femora being black except at the tip, the tibiæ and tarsi being dull yellow. The radius forms an angle with the basal vein of the areolet at their point of union: the base of the third abdominal joint is punctate.

As it is probable that *flaviconchæ* is a parasite of the Army-worm, it may be well to compare it with *militaris*. In *Ap. militaris*, which I have bred from *Nephelodes violans* as well as from the Army-worm, the stigma is not so dark, the radial vein passes into the basal vein of the areolet quite evenly, the base of the abdomen beneath is reddish and the coxæ as well as the femora are red, the knees dusky. It more particularly differs from *flaviconchæ* and from other allied species in a character hitherto unrecorded; the basal joints of the abdomen are quite smooth, and on the second joint two oblique grooves are very distinct.

APANTELES CONGREGATUS (Say).—Under this name* must be grouped a long series of forms attacking various Sphinges, Bombycids and Noctuids, and perhaps other Lepidoptera. But for the present I will mention only those bred in Missouri from *Chærocampa pampinatrix*, *Sphinx 5-maculata*, and two unknown species of Sphingid larvæ, those bred from *Sphinx catalpæ* from Knoxville, Tenn., those bred from *Leucania unipuncta* in Missouri in 1869 and in Connecticut in 1880, and those bred from *Hemileuca maia* and *Saturnia Io* in Missouri. The species is characterized by the rough first and second abdominal joints and by the legs, excepting the posterior coxæ, being red. The antennæ vary from black to testaceous, and the abdomen is either entirely black or is marked with red on some of the joints. The metathorax has an indistinct median line. The radius arises beyond the middle of the stigma and passes into the basal vein of the areolet with quite an even curve, except in the specimens bred from *Saturnia* and *Hemileuca* (to which I would give the variety name *hemileucæ*), which have a distinct angle at the point of union. In var. *hemileucæ*, also, the second abdominal joint is slightly less coarsely sculptured than in specimens bred from Sphinges and Army-worms. This variety agrees with those parasitic on Sphinges in forming clear white cocoons spun separately upon the back of its host and not enveloped in loose silk.

Specimens bred from the Army-worm in Missouri in 1869 from bunches of cocoons enveloped in dull whitish floss silk have the abdomen entirely black, but from similar bunches of cocoons was bred a form which, while agreeing in sculpture, has more or less of the first, the second and base of the third joints red, the

* The insect described by Provancher under this name is not Say's species, but is a synonym of *gelechiæ* Riley.

coxæ red, and the basal half of the antennæ yellow. This variety may be named *rufocoxalis*. That it is only a variety is evident from my having bred in May from similar bunches of cocoons, both in Missouri and in Washington, specimens which agree in all characters, but vary in having the third joint of the abdomen either black, piceous, or red, and in the first and second joints also being more or less red, and in the coxæ being blackish at the base. Army-worm specimens bred in Connecticut in 1880 from irregular masses of whitish cocoons not concealed by a covering of loose silk differ from the typical *congregatus* in having lateral red fasciæ on the third and fourth, and in the male on the fifth, joints of the abdomen, the fasciæ in the male being sometimes continuous. One specimen has a pair of red dots on the third joint only. But in other respects these parasites of the Army-worm agree with those from the Sphinges.* A variety which I have bred from *Arctia virginica* in Missouri, and which may be named *scitulus*, varies further in having the base of the third abdominal joint more or less sculptured and in the abdomen beyond this, except along the middle, and in the entire under surface of the abdomen being red. The radius in some specimens forms an angle with the basal vein of the areolet at their point of union. The cocoons are spun parallel to one another, but not in an even series, on a leaf, and are enveloped in white floss silk.

The difference in the cocoons may easily be due to the difference in the conditions under which they were spun. The Army-worm being amid the grass, the Microgasters can there most readily attach their cocoons in a mass to the blades or stems, but when emerging from a Sphinx caterpillar they have only the body of their host for a support and each one must take care of itself. The Microgasters bred from the cluster of parallel cocoons represented in Fig. 9, and which were referred to in the "American Entomologist," vol. i. p. 224, as found on the branch of a dwarf apple tree by Mr. Henry Kleinhaus of Nyces, Penn., agree with specimens of *congregatus* bred from Sphinges, except in the second abdominal joint being polished and only slightly punctured, or only finely

Fig. 9. — Parallel cocoons, found on apple twig.

* I have still another Microgaster parasite bred from the Army-worm. It differs from the others in belonging to the genus *Microplitis* and in being solitary, only a single maggot deriving nourishment from the partially grown Leucania larva. The specimen is, however, too poor to describe from.

striate. They might be considered a variety, but hardly more. I have found similar cocoons at Lawrence, Kansas, and bred the same kind of flies from them, some of the specimens varying in having red marks on the third and fourth joints of the abdomen. The spinning of the cocoons in these honey-comb-like masses seems also to be due to the place of spinning, as they were in each case attached to tree-branches; the larvæ doubtless finding that they could obtain a firm support only in a position transverse to the branch and their host.

From *Sphinx 5-maculata* I have obtained cocoons such as those represented on *Chærocampa* in Fig. 4, and have received from Mr. N. A. Bibikov, Orangeburg, S. C., the same kind of cocoons from a Tomato-worm, and all have produced *Apanteles congregatus*. But, strangely enough, the mass of cocoons represented at Fig. 5 may also have been made by parasites of *Sphinx 5-maculata*, for I have received a similar mass obtained from that species by Mr. E. T. Dale of Yellow Springs, O., and the flies bred therefrom, as far as the few specimens before me will permit of comparison, present no characters distinguishing them from those bred from the other form of cocoons. With more material I hope a closer comparison may be made. These masses of cocoons must be spun under very different circumstances from those under which the others are spun.

APANTELES SMERINTHI, n. sp.—Length 2–2½ mm. ♂♀. Black; labrum, mandibles and palpi testaceous; the tips of the palpi whitish, antennæ dark testaceous; legs light red, the anterior and intermediate coxæ reddish, the posterior coxæ black; wings hyaline, tegulæ and nervures testaceous, the stigma a little darker; lateral edges of the first and second joints of the abdomen testaceous, a spot on each side of the third joint and sometimes the apical margin of this joint red, the three basal joints reddish beneath. Mesothorax even, shining, the punctures being very fine and not close together. Metathorax finely reticulate, with a slight median ridge. Abdomen polished, the basal joints with slight distinct punctures, not rugose. Ovipositor concealed. The radial vein arises beyond the middle of stigma and passes into the basal vein of the areolet quite evenly.

Described from many specimens bred from *Smerinthus ocellatus*, June 10, 1872. At once distinguished from *congregatus* by the shining, delicately punctured mesothorax. In other respects, excepting the finer sculpture of the base of the abdomen, it closely resembles that species. The cocoons are spun in a mass, arranged parallel to one another in a single row, the whole enveloped in loose white silk and attached to a willow leaf.

A bunch of weathered cocoons, of a dirty whitish color, found on a willow leaf—probably found in the same locality with the above near St. Louis — are peculiar for having the cocoons arranged in a double row, just like the cells in a honey-comb. From these cocoons I have bred flies which have unfortunately been much broken, but they have the peculiar polished thorax of *smerinthi*, and agree otherwise as far as the imperfection of the specimens will permit of comparison.

APANTELES ACRONYCTÆ, n. sp. (Riley MSS., 2d Rep. Ins. Mo., p. 120). Length $2\frac{1}{2}$ mm. ♂. Black; labrum and mandibles testaceous, palpi whitish, antennæ piceo-testaceous; legs light red, posterior coxæ black; wings hyaline, the tegulæ piceous, nervures and stigma testaceous; lateral edges of the first and second joints of the abdomen, and the sides of these joints beneath, testaceous. Mesothorax shining, uneven behind, there being one or two shallow pits before the scutellum caused by the union of the lateral oblique grooves, although these grooves are not clearly defined and are not apparent anteriorly. Metathorax granulated or finely reticulate, with an indistinct median ridge. First and second joints of the abdomen confluently punctate, opake; remaining joints smooth and shining. The radial vein arises beyond the middle of stigma and passes into the basal vein of the areolet quite evenly.

Differs from *congregatus* and agrees with *smerinthi* in its shining mesothorax, but differs from the latter in the mesothorax being uneven, in the opake basal joints of the abdomen, and in the lack of red marks on the third joint.

Described from nine specimens bred from larvæ of *Acronycta populi** taken at Bloomington, Ill. The maggots issued Sept. 15th, the flies Sept. 23d. "Many of the Acronycta larvæ when full grown will fasten themselves firmly to a leaf in the curled position, and from the body will issue from thirty to forty little maggots. These maggots are each of them 0.17 inch long, of a dull green color, tapering each way, with a dark dorsal mark, a lateral elevated ridge, and a row of shining elevated spots of the same color as the body between the ridge and the back. Each one spins a mass of white silk around its body and creeps out of it and commences spinning afresh, until at last a large aggregate amount of flossy silk is spun, into which the maggots work back

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* *A. populi* Riley = *A. Lupusculina* Gn.

to transform, though some transform while lying on the surface."* The silk is spread out upon the leaf about the caterpillar in an irregular mass and no definite cocoons are visible.

APANTELES PALEACRITÆ, n. sp. — Length 2½–3 mm. ♂♀. Black; labrum, mandibles and antennæ piceous, palpi whitish; legs red, anterior coxæ piceous, posterior black, the posterior femora at tip, the apical half of posterior tibiæ and the posterior tarsi excepting the base of the joints, black; wings hyaline, tegulæ piceous, nervures testaceous, stigma darker; lateral edges of the basal joints of the abdomen and the sides of these joints beneath piceous or testaceous. Mesothorax densely punctured; metathorax sparsely punctured, without median ridge. First and second joints of the abdomen rugose, the second joint with two distinct oblique grooves (in the Canadian specimens the middle of the joints almost smooth); remaining joints smooth. Ovipositor concealed. The radial vein arises beyond the middle of stigma and passes into the basal vein of the areolet quite evenly.

Described from 3 ♀s, 1 ♂, bred from the larva of *Paleacrita vernata* found at Villa Ridge, Southern Illinois, the flies appearing May 20th, and from 2 ♀s bred from Canker-worm larvæ, probably of the same species, received from Mr. J. Pettit, Canada West. The greenish-white cocoons are spun singly on the under side of a leaf. The flies differ from *congregatus* in the oblique grooves on second joint of abdomen and in the dark posterior tibiæ and tarsi.

LIST OF NORTH AMERICAN SPECIES HERETOFORE DESCRIBED.

All the species following have been described under the generic name *Microgaster*, that term being employed indiscriminately for the three genera treated of in this article, and it may be noted that all specific names should have been feminine. The original spelling is here quoted because the names of such species as may be referred to *Microplitis* or *Apanteles* will retain or take a masculine form. It may ultimately be found that *mellipes* Say, *bistigmata* Say, and possibly some of the other described species, do not really belong among the Microgasters.

UNITED STATES.

calliptera Say, Bost. Journ. Nat. Hist., i. 264 (1836). Probably a [*Microplitis*.

* Second Report on the Insects of Missouri, 1870, p. 120.

croceipes Cress., Trans. Am. Ent. Soc., iv. 183 (1872) Tex. *Micro-* [*plitis?*
maculipennis Cress., " " " " " " " "
iridescens Cress., Proc. Ent. Soc. Phila., iv. 68 (1865). Cuba. "

zonaria Say, Bost. Jour. Nat. Hist., i. 263 (1836). Apparently a [*Microgaster.*
gelechiæ Riley, 1st Rep. Ins. Mo., 178 (1869). A true "

carpata Say, Bost. Journ. Nat. Hist., i. 263 (1836). An *Apanteles.*
congregata Say, Bost. Journ. Nat. Hist., i. 262 (1836).
Fitch, 9th Rep., 222 (1865). = *utilis* French, Can. Ent. xii. [42 (1880).
militaris, *var.* Riley, 8th Rep. Ins. Mo., 54 (1876).

This species was bred by Say from a Sphinx larva, and must, I think, be the same as that described by Fitch. The words "radial cellule with the nervure as obvious as the others; second cubital cellule rounded destitute of the exterior nervure." in Say's description, might throw a doubt on his insect being a Microgaster at all: but there is an inconsistency in the second cubital cellule being open and rounded in the same insect. No other small Ichneumonids are known to attack Sphinx larvæ in the manner he describes, the insect mentioned in my first Report on the Insects of Missouri (p. 96 note) as a species of *Blacus*, on Mr. E. Norton's authority, being this common *Apanteles.*

ensiger Say, Bost. Journ. Nat. Hist., i. 260 (1836). The open areolet of the ♀ would place that sex in *Apanteles*, but the ♂ is said to have the areolet closed. Say must have confounded two quite distinct insects.
limenitidis Riley, 3d Rep. Ins. Mo., 158 (1871). An *Apanteles.*
militaris Walsh, Ins. Inj. to Veg. in Ill., 37 (1863). " "
Riley, 2d Rep. Ins. Mo., 52 (1870).
nephoptericis Pack., Proc. Essex Inst., iv. 122. pl. 3, f. 3, 3*a* (1864). An *Apanteles.*
xylina Say, Bost. Journ. Nat. Hist., i. 262 (1836). " "

CANADIAN.

cinctus Prov., Nat. Can., xii. 196 (1881). Quebec. An *Apanteles.*
clavatus, Prov., Nat. Can., xii. 196 (1881). " Probably a sy- [nonym of *Ap. carpatus.*

ARCTIC.

Halii Pack., Am. Nat., xi. 52 (1877). Greenland.
unicolor Curtis, Ross's 2d Voyage, App. p. lxii. Arctic America.

CUBAN, ETC.

americanus Latr., Encycl. Meth., Ins. 10, 42 (1825). Martinique.
flaviventris Cress., Proc. Ent. Soc. Phila., iv. 66 (1865.) Cuba. An [*Apanteles.*
hyalinus Cress., " " " " " 68 " Cuba. "
mediatus Cress., " " " " " 66 " "
marginiventris Cress., " " " " " 67 " " An [*Apanteles.*
pinos Cress., " " " " " " " " "

OF DOUBTFUL GENUS.

bistigmata Say, Bost. Journ. Nat. Hist., i. 264 (1836). The open areolet allies it to *Apanteles*, but the distinct radial vein and supplementary stigma render the location of the species doubtful.

mellipes Say, Bost. Journ. Nat. Hist., i. 261 (1836). Agrees with *Apanteles* except in its distinct radial vein and subfusiform abdomen. The "thorax with its two oblique impressed lines confluent behind" is also a peculiar character, although there is an indication of it in *Microplitis ceratomiæ.*

robiniæ Fitch, Fifth Report, p. 56 (1859). The open areolet points to *Apanteles*, but the brevity of the description produces doubt.

Descriptions of some New TORTRICIDÆ *(Leaf-rollers).*

By CHAS. V. RILEY, M.A., Ph.D.

(Communicated Mar. 21, 1881.)

The study of the Tortricidæ in this country will undoubtedly receive an impetus from the recent publication of Lord Walsingham's admirable work on the Family.* Prof. C. H. Fernald of the State College, Orono, Me., has been for some years devoting especial attention to these moths, which greatly interest the cultivator of flowers, fruits, and trees, on account of the frequency with which their larvæ (Leaf-folders) are met with, sometimes in injurious numbers. In the spring of 1878 I sent to Prof. Fernald some notes upon about a hundred species of which I had studied the habits and adolescent states, indicating a few of the undescribed forms by MS. names. These Prof. Fernald has kindly retained in his determinations, and I am under obligations to him not only for this courtesy, but for the generic references of most of the species here treated of, and for other valuable assistance in determinations. I am likewise under obligations to Mr. Wm. H. Patton, of Washington, for courteous assistance and advice, and to Miss M. E. Murtfeldt of Kirkwood, Mo., for aid in rearing some of the species.

CONCHYLIS ŒNOTHERANA, n. sp.—♂♀. Expanse 9-10 mm. Basal half of primaries yellow, apical half rose-red. *Head* gray. *Thorax* yellow, the patagia tipped with gray: *primaries* with the basal half yellow, the costa and apical half rose-red, the yellow extending as a broad median emargination into the red; the red portion more or less dotted or fasciate with black shining scales, these scales not encroaching upon a central patch which contains a yellow spot of variable size; some abbreviated black and white costal streaks; posterior margin and fringes yellow, becoming gray at the anal angle: *secondaries* and *under surfaces* fuscous: *legs* silvery, the tibiæ and tarsi mostly black or fuscous. *Abdomen* silvery-fuscous, paler beneath; ovipositor laterally compressed.

Described from four specimens bred from *Œnothera*, in Missouri, by Miss Murtfeldt.

CONCHYLIS ERIGERONANA, n. sp.—♂. Expanse 11 mm. Head, thorax and basal third of primaries creamy-white, the median and apical third of primaries blackish. *Head* white, palpi beneath and antennæ fulvo-testa-

* Lepidoptera Heterocera in the British Museum, Part. iv., North American Tortricidæ.

ceous. *Thorax* white: *primaries* with the basal third creamy-white, with a fulvous tinge which is most pronounced along the costa; the median third occupied on the inner border by a broad dark fuscous band which narrows towards the costa at its middle; the apical third marbled with spots of shining scales (with steel-blue reflection) upon a fulvous ground, the costa fulvous; a longitudinal black mark on median vein, and others in ocellus apparent under a lens; fringes black tinged with gray; *secondaries* gray: *under surfaces*, primaries fuscous, with some black and ochreous costal streaks, fringes tipped with black; secondaries gray: *legs* blackish, the posterior pair white above, tinged with fulvous beneath. *Abdomen* —— (broken in the specimen).

Described from one specimen bred Feb. 24, 1879, from a Cecidomyidous gall on *Erigeron canadense?* received from Columbia, Texas (E. A. Schwarz).

EXARTEMA MONETIFERANUM,* n. sp.—♂. Expanse 20 mm. Primaries brownish with numerous straw-colored spots ocellated with carneous inclining to pink. *Head* grayish, antennæ and apical joint of palpi tinged with piceous. *Thorax*; tegulæ gray, with a median fuscous band: *primaries* brownish; a pale basal spot, a fascia of three pale spots just beyond, succeeded by a fascia of four similar spots, and this followed at the middle of the wing by three similar spots which do not unite to form a fascia; beyond the middle a Y-shaped fascia, its stem obliquing basally, the anterior branch reaching costa about the middle of wing, the posterior about the outer fourth and connecting with the first of two small costal spots which form a continuation of a broad irregular terminal fascia; apical angle and middle of posterior margin brown; fringes tawny, with a darker basal coincident shade: *secondaries* dark gray, fuscous at apical angle; fringes light gray with a darker coincident basal line: *under surface* of primaries deep fuscous, the markings of upper surface faintly indicated on disc, but distinctly on costal and posterior margins; secondaries gray, darker towards tip: *legs* silvery, anterior coxæ and femora within ashy, the anterior and intermediate tibiæ and tarsi marked with fuscous, posterior tibiæ with a black line within. *Abdomen* fuscous, the margins of the joints silvery, caudal tuft ochraceous; abdomen beneath whitish-ochraceous, and with a series of median fuscous shades.

One specimen from Eufaula, Ala. (G. W. Latimer).

EXARTEMA FERRUGINEANUM, n. sp.—♂. Expanse 17 mm. *Head* ferruginous; clypeus and palpi, excepting the black apical joint and dots on the preceding joint above, white; antennæ fuscous, slightly pubescent, the basal joint ferruginous. *Thorax* above ferruginous: *primaries* dark ferruginous with a faint olivaceous hue, and with irregular fasciæ and

* I follow the prevailing custom of conforming the specific termination to the gender of the genus, though in my judgment the value of the ending as a means of readily indicating the group or family to which an insect belongs is thus largely destroyed, and it were better to look upon it as purely conventional and to keep it uniform regardless of the genus.

streaks of bright ferruginous enclosing a median, faintly bluish line; the first pale fascia extending from costa to inner margin and forming two indentations in the basal patch; the second fascia, originating just beyond the middle in two oblique costal streaks which reach to the next costal streak beyond them, extending to the posterior margin near the anal angle and giving off from its inner edge a branch along the cell, which connects more or less distinctly with the first fascia, and a second branch which, at first running at right angles to the fascia and toward the inner margin, suddenly bends before attaining that margin and extends to the first fascia, with which it unites just below the median vein; towards the apex three oblique costal streaks which converge towards the middle of the posterior margin; the fringes fuscous, darker at the apex and in the middle, and with a narrow basal fuscous coincident line; the ground color of the wing most distinct in the basal patch, the broad central band divided into three broad streaks and in an oblique patch extending inward from below the middle of the posterior margin : *secondaries* fuscous, pale toward the base, their fringes whitish with a dark basal coincident shade : *under surfaces* silvery-fuscous, the primaries slightly tinged with coppery : *legs* silvery-white, the anterior tibiæ and the tarsi streaked with fucous above. *Abdomen* above fuscous, beneath silvery-white.

Described from two ♂s bred from larvæ feeding on plum leaves at St. Louis, Mo.

In the general color of the wings and the division of the central band this species approaches *Ex. nitidana* Clem., but the basal patch and central band of that species are pure brown. From *Ex. sericorana* Walsm. it differs in the failure of the second branch from the second fascia to attain the inner margin, and in the extension of the two streaks to a union with the first fascia. The blue line in the first fascia also is much narrower than that represented in Walsingham's figure of *Ex. sericorana.*

The general coloration of *Ex. permundana* Clem. at once separates that species, which also has the second branch of the second fascia extending to the inner margin. Otherwise the fasciation is very similar.

PÆDISCA GIGANTEANA, n. sp.—♀. Expanse 34-38 mm. General color white, with a large brown patch enclosing the anal angle and the ocellated spot. *Head* white, antennæ testaceous. *Thorax* white : *primaries* white, some fuscous dots on costa and some mottlings or abbreviated fasciæ of pale fuscous about the basal third of the wing between the cell and the inner margin; the posterior third of the wing, including the apical angle but not extending upon the costa, fuscous, with irregular spots and fasciæ of polished elevated scales and with white mottlings toward the apical angle and posterior margin, the median terminal portion with some irregular black lines : *secondaries* and *under surfaces* grayish fuscous : *legs* white, the anterior tarsi tinged with fuscous above. *Abdomen* whitish, the apical joint of the ovipositor piceo-testaceous, laterally compressed, evenly chitinized, stout.

Described from two specimens; Kansas (G. F. Gaumer); Iowa, March, 1874 (Hoffmeister). Prof. Fernald, having a male of this species, informs me that that sex agrees in coloration with the females, and has the costal fold characteristic of the genus.

PÆDISCA CELTISANA, n. sp.—♂. Expanse 15.5 mm. Ashy, the primaries mostly ashy-fuscous. *Head* ashy. *Thorax* ashy-brown: primaries pale fuscous with a slight coppery reflection; base toward the inner margin white, the middle of the inner margin with an elongated ashy-white patch; costa and disc of the wing slightly speckled with white and black, the black most distinct on the costal border of the large white patch; an apical dark fuscous spot; fringes ashy, speckled with fuscous and preceded by a white line: secondaries ashy: under surfaces ashy, the primaries tinged with fuscous: *legs* ashy, varied with fuscous on the tibiæ and tarsi. *Abdomen* ashy, paler beneath.

Described from one specimen bred from *Celtis* in Texas (Boll.) Prof. Fernald thinks that this may prove to be one of the varieties of *vertumnana* Zell.

SEMASIA HELIANTHANA, n. sp. — ♂. Expanse 15 and 20 mm. Whitish gray, the primaries with two quadrate blackish patches on inner margin and with a black dash and white triangle at the apical angle. *Head* pale gray, apical joint of palpi in one specimen fuscous, antennæ fuscous. *Thorax* pale gray: *primaries* gray; streaked with white and fuscous along the costa; base of wing dark gray, this followed by pale gray, which is in turn followed on the inner margin by a quadrate black or dark brown patch before the middle, this patch produced to a point posteriorly upon the disc of the wing, and in the larger specimen faintly connected there with some of the costal streaks; a similar spot on the inner margin before the posterior angle, extending in the larger specimen upon the disc of the wing before the ocellated spot and there connected with a light brown streak extending from the middle of the costa: ocellated spot white, containing a black dot and upon its costal border two longitudinal black lines; a light brown streak from the outer third of costa extending around the apical border of the ocellated spot to attain the middle of posterior margin; apical angle with a black dash, preceded upon the costa by a conspicuous geminate white triangle, the space behind which has a slight fulvous tinge; fringes gray, speckled with dark brown or black in the smaller specimen: *secondaries* gray with lighter fringes: *under surface* of primaries fuscous, the streaks indicated on the costa; of secondaries silvery-gray: *legs* gray, the four anterior tibiæ and tarsi marked with blackish above. Abdomen gray.

Described from two specimens bred from galls, of the usual Lepidopterous character, on the commoner Western Sunflower in Texas, Aug. 12 and 17, 1873.

This must closely resemble *Steganoptycha variana* Clem. and *St. lagopana* Walsm., but I refer it to the genus Semasia at Prof. Fernald's suggestion.

GRAPHOLITHA GALLÆ-SALICIANA, n. sp.—♂. Expanse 11 mm. White, the primaries blackish on terminal third, the secondaries gray. *Head* white, the antennæ with a black line beneath. *Thorax* white: *primaries* white, tinged with ochraceous along the costa beyond the middle and spotted with grayish-brown on costa, and, more particularly, towards the inner margin; the space included between the apical angle, the anal angle, and the middle of the inner margin, fuscous, ocellated spot silvery tinged with lavender, enclosing a gray and one or two jet black spots and preceded by a black transverse spot; a silvery streak from the costa to just beneath the apex, and a shorter parallel silvery streak extending from the middle of the costa; fringes fuscous with a silvery reflection, preceded by a black marginal line: *secondaries* fuscous, fringes silvery: *under surfaces* fuscous, markings of primaries faintly repeated: *legs* silvery-white. *Abdomen* fuscous above, silvery-white beneath, excepting the apical joint.

Described from two specimens bred June 17, 1873, from galls on willow twigs, St. Louis, Mo.

At once distinguished from the European *campoliliana* by its pure silvery or satiny-white coloration untinged with yellow. Its general color is that of the European *Spilonota roborana** Schiff, but it is much smaller and is very differently marked.

GRAPHOLITHA OLIVACEANA, n. s.—♂. Expanse 18 mm. *Thorax* olivaceous: *primaries* olivaceous with a pale ochraceous tinge; an oblique streak from the middle of the costa connecting with a broad, somewhat wavy stripe which extends through the middle of the wing to just before the apex; two spots on inner border, one near base, the other (which is larger and more elongate) toward anal angle, and some costal and apical streaks brown-olivaceous; ocellated spot silvery, the centre ochraceous with two black stripes; a silvery streak extending obliquely from the costa to the posterior margin; fringes ochraceous, tinged with fuscous at apex: *secondaries* gray, fuscous towards tip; fringes white, dusky at base: *under surface* of primaries fuscous; the fringes, except at apex, and some costal spots ochraceous; secondaries gray.

Described from one specimen from Illinois (J. R. Muhleman).

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* This is, according to Staudinger & Wocke's catalogue, synonymous with *cynosbana* Fabr. described in 1775; also with Hübner's *aquana*. It is, beyond much doubt, the same as *Hedya scudderiana* Clem., *Euryptychia saligneana* Clem. and *Pædisca affusana* Zell.

PROTEOTERAS,* Nov. Gen.

Venation and notch in posterior border of primaries as in *Proteopteryx* Wlsm., but the primaries with tufts of raised scales on upper surface, and the secondaries in the ♂ with a large pencil or tuft of hairs on upper surface in the space between the margin and the costal vein.

PROTEOTERAS ÆSCULANA, n. sp.—♂♀. Expanse 14 to 17 mm. General color grayish-fuscous, with an olivaceous hue on the primaries, which are roughened and have 5 nearly equidistant knobs of elevated scales along the inner third (the 2d and 4th from base being largest, the 5th, at base of ocellated patch, smallest), and one knob on the disc of the wing opposite the second from the base. Under a lens is revealed an admixture of gray, silvery, black and olivaceous scales, which, together with the knobs, creases and other irregularities of the wings, when naturally folded, strongly recall in appearance the lichened bark of a tree. *Head* greenish, the palpi beneath and the clypeus white, antennæ fusco-testaceous. *Thorax* greenish, the patagia tipped with pale scales: primaries mottled with green and grayish white; numerous abbreviated costal streaks and a longitudinal line along the inner branch of the subcostal vein and often continued in dots towards the apex, black; the green most pronounced on the inner half of the wing, in a band extending towards the basal third of costa, and in a band beneath the black line, the latter band reaching the costa at the middle and produced on the other side in mottlings toward the apex; a broad oblique band starting from the costa before the middle, the ocellated spot and the space above the black line, light gray; fringes grayish-olivaceous: *secondaries* fuscous, their fringes but slightly paler; in the male a black line along the costa and another along the costal vein, these two lines enclosing a broad whitish stripe upon which rests a tuft of long gray scales arising near the base of the wing, upon the costa opposite the base of the tuft some erect black scales: *under surfaces* pale fuscous, a black stripe along the costa of all the wings in the male: *legs* white, the four anterior tibiæ banded with green, their tarsi black with the tips of the joints white, posterior tibiæ and tarsi shaded with gray. *Abdomen* fuscous, margins of joints gray, beneath white; last ventral joint of the female with a median slit and with a naked dot on each side; chitinous valve of the ovipositor mostly concealed, flat, narrow, apex slightly emarginate, the angles rounded: last ventral joint of the male with a median interruption in the scales; the claspers concealed by a covering of loose scales; lateral tufts of the apical joint distinct.

There is considerable variation in the ground color, some specimens having the pale marks predominant, some the green. Some specimens are more or less suffused with ferruginous inclining to tawny, and there is frequently a tawny spot at base of ocellated spot. The black irregular streaks in the dark fascia curving from middle of costa towards apex are persistent.

* Πρωτεύς, *Proteus*; *Teras*, a genus of Tortricids.

Described from eight specimens bred from larvæ boring the tender terminal twigs of Buckeye and of Maple in Missouri.

The indentation in the posterior border at the apex of vein 4 is often difficult to detect on the upper surface because of the heavy fringe, but on the lower surface it is always distinct. Vein 4 comes very close to vein 5 at the apex.

MELISSOPUS,* Nov. Gen.

Primaries twice as long as wide, the costa gently and evenly arched, posterior margin scarcely indented below the apex; no costal fold: venation as in *Carpocapsa pomonella*: the wing banded with coppery. *Secondaries* slightly indented below the apex: venation differing from that of *C. pomonella* in vein 2 springing from the basal third of the discal cell: behind and parallel to the base of the median vein and vein 2 a pencil of hairs concealed in a much deeper pocket than that of *Carpocapsa*, the pocket forming a conspicuous process on the lower surface of the wing: a dense cluster of peculiar hair-like scales, with broadly spatulate tips, along the inner border. *Posterior tibiæ* dilated and compressed, clothed with long scales forming a large brush resembling a miniature and flattened "feather duster": the posterior tarsi also with long scales, particularly on the basal joint which is also dilated.

This genus resembles *Ecdytolopha* Zeller (Beiträge z. Kennt. nordam. Nachtfalter iii. p. 60 [266]) in some respects, but may easily be distinguished by the absence of the stout scutellar tuft which belongs to that genus; by the singular mat of spatulate hairs on the anal margin of secondaries, and by the peculiarly broad and brushy hind tibiæ and tarsi.

MELISSOPUS LATIFERREANA (Wlsm.)—♂. Expanse 17–18 mm. General color reddish-brown, with metallic reflections on the primaries. *Head* grayish-brown; palpi white, exteriorly towards tip fuscous. *Thorax* above speckled with gray and brown: *primaries* reddish-brown, speckled with gray, especially at base; a rather narrow coppery median fascia, almost straight, constricted at middle and widest on the inner margin; a second more arcuated fascia of the same color, broadest along the ocellated spot and broken just above it, and a third, narrower and more broken, fascia extending from outer fifth of costa and curving near posterior margin to anal angle; ocellated spot merely indicated by a series of interrupted, black longitudinal lines and a few black specks along inside of the posterior metallic fascia; a few metallic costal streaks and an apical spot of same color; fringes gray, preceded by a dark red terminal line: *secondaries* fuscous, paler toward the base, fringes whitish;

* μέλισσα, bee; πούς, foot.

the hair pencil yellow; the mat of spatulate scales near inner border pale yellow: under surfaces fuscous, with a faint, coppery reflection: *legs* and thorax beneath gray, posterior tibiæ and tarsi white above and grayish-fucous beneath. *Abdomen* fuscous.

Described from two specimens bred June 1, 1876, from acorns, mostly those infested with *Balaninus* larvæ. Either a genuine acorn borer or inquilinous. Kirkwood, Mo. One from Dallas, Tex. (Boll.)

I have given the above description of the male of what is doubtless *Carpocapsa latiferreana* Wlsm. (N. A. Tortricidæ, p. 70, pl. 76, f. 8) because the genus is at once distinguished from *Carpocapsa* by the greatly dilated posterior legs of the male, and in order to show the varietal differences indicated by Walsingham, strengthened by the black streaks in the ocellated spot being longitudinal, not transverse. As his two specimens were ♀s and mine are both ♂s, the presumption is that these colorational differences are not of specific value, and this is Prof. Fernald's conclusion after seeing the types and comparing specimens from New Hampshire and Texas. Should future observation show them to be distinct, I would propose for mine the name of *aurichalceana*, the specimens being so referred to by Walsingham.

PHOXOPTERIS MURTFELDTIANA, n. sp.—♂. Expanse 10 mm. White, the primaries with a dark brown patch on basal half of inner margin and with an oblique fascia extending from the middle of costa. *Head* reddish-brown; palpi white, tinged with brown at base. *Thorax* white, becoming embrowned on the disc: *primaries* white, the apical half shaded with ferruginous, with a broad blackish-brown patch on the basal half of the inner margin, the patch rounded on its costal border and having a very indistinct coppery reflection from some of the scales in particular lights; from the middle of the costa an oblique reddish-brown fascia extending to form a sharp angle just before the apex of wing (there enclosing two black streaks) and retreating suddenly to curve around the ocellated patch, into which it sometimes sends a slight angle, and to attain the inner margin of the wing; this fascia much paler on its inner half than on its costal half, bounded exteriorly, from costa to inner margin, by a white line and shading off on the inner half of its basal border into the white ground color; costa beyond the fascia to the apex streaked with white and ferruginous, the apex ferruginous, just below the apex two white streaks; ocellated patch white, generally containing a black streak; posterior margin ferruginous; fringes tinged with ferruginous, pale at base, darker at apical angle: *secondaries* gray: *under surfaces* gray; primaries shaded with fuscous: *legs* white, with the usual fuscous shadings on tarsi. *Abdomen* gray, silvery beneath.

Described from three specimens bred from oak, May 19, by Miss Murtfeldt, in Missouri.

From *Ph. spireæfoliana*, which Dr. Clemens bred from larvæ found feeding on the leaves of *Spiræa opulifolia*, this oak-feeding species differs in the oblique central fascia extending to form a sharp angle towards the apex of wing, in the angulated portion containing two black streaks, and in this fascia extending, as a faint band, to the inner margin and beneath the ocellated patch.

Ph. burgessiana Zell., which may not be distinct from *pulchellana* Clem., and *Ph. laciniana* Zell., which may not be distinct from *dubiana* Clem., are closelly allied to *murtfeldtiana*, but the basal patch is darker than in those species, thus resembling *spireæfoliana*.

PHOXOPTERIS CORNIFOLIANA, n. sp.—♂. Expanse 10 mm. Basal half of primaries steel-blue, changing to reddish-brown towards the inner border; apical half ferruginous with steel-blue and white shadings. *Head* closely scaled, ferruginous, clypeus whitish; antennæ piceous except towards base; palpi short, not extending beyond head, closely scaled, whitish. *Thorax* above ferruginous: basal half of *primaries* steel-blue, becoming whitish on the middle of the inner margin, a large basal patch behind the median vein reddish-brown, in one specimen this patch extending on the disc to form a union with the ferruginous apical half of the wing so as to cut off a large subtriangular pale patch on the middle of the inner margin; apical half of wing ferruginous, pale along costa and within the ocellated patch, which is represented by a steel-blue shade on the anterior border of which there are two parallel dark lines and which is edged terminally with white; costa streaked with white and reddish-brown, from near the middle of costa a steel-blue streak extending to just beneath the apex, where it is met by a more delicate streak extending nearly perpendicularly from the costa; fringes grayish-ferruginous, preceded by a fuscous line in the excavation: *secondaries* fuscous, with the basal half whitish; fringes white, becoming fuscous toward apex: *under surface* of primaries fuscous, with some whitish costal streaks; secondaries white, with fuscous margins and apex: *legs* silvery, tibiæ and tarsi with fuscous shadings. *Abdomen* fuscous, silvery-white beneath.

Described from two specimens bred from larvæ on *Cornus paniculata*, April 7, 1878, at Manhattan, Kans.

Differs from *Ph. muricana* Wlsm. in the increase of the reddish-brown color at the expense of the white, the ocellated patch being represented only by the steel-blue spot edged posteriorly with a white line; and in the white base of the secondaries. Yet, as Walsingham described only the ♂, it is possible that this is the other sex of his species.

On Certain Problems in Refraction.

By FRANCIS E. NIPHER.

While observing, as I had often done before, the dished appearance of a flat-bottomed vessel as seen through a water surface, it occurred to me that I had never seen a discussion of the shape of such an apparent bottom, nor have I since been able to find such discussion.

1°. To find the shape of the apparent bottom of water when the real bottom is a horizontal plane.

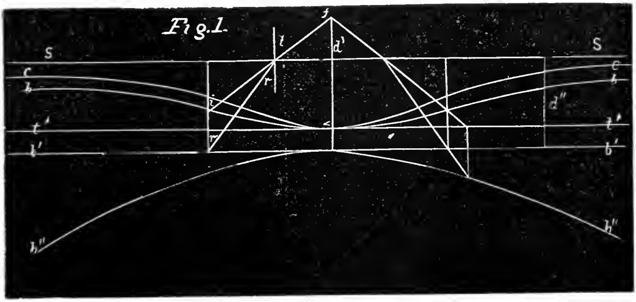
Let d' = the altitude of the eye above the surface;
d'' = the real depth of the water;
d = the apparent depth of the water at a distance;
L = abscissa of the point at d.

The origin of the coördinates L and d is in the surface immediately under the eye.

The angle of incidence has been taken in the medium containing the eye, and hence the point occupied by the eye may also be considered as a radiant point.

By the law of refraction

$$\frac{\sin i}{\sin r} = n. \qquad (1)$$



EXPLANATION OF CUT.

ss = water surface.
cc = conchoid of Nicomedes.
bb = corresponding refraction conchoid.
$t'\,t'$ = apparent bottom for Problem II.
$b'\,b'$ = bottom for Problem I.
$b''\,b''$ = bottom for Problem II.

The two triangles having a common base in the water surface (Fig. 1), their vertices being at the bottom and the apparent bottom, give the relation

$$d = \frac{\tan\ r}{\tan\ i}\, d'' = \frac{1}{n} \frac{\cos\ i}{\cos\ r}\, d''. \qquad (2)$$

From equations (1) and (2) we have

$$d = \frac{d''}{n} \sqrt{\frac{1 - \sin^2 i}{1 - \frac{\sin^2 i}{n^2}}}. \qquad (3)$$

But

$$\sin\ i = \frac{L}{\sqrt{(d' + d)^2 + L^2}}$$

and this value in (3) gives

$$d = \frac{d''}{n} \sqrt{\frac{n^2(d' + d)^2}{n^2 (d' + d)^2 + (n^2 - 1) L^2}}$$

which readily takes the form

$$L^2 \left\{ \frac{n^2 - 1}{n^2} \right\} = (d' + d)^2 \frac{\left\{ \frac{d''^2}{n^2} - d^2 \right\}}{d^2}. \qquad (4)$$

The equation of the conchoid of Nicomedes is

$$x^2 = \frac{(b + y)^2 (a^2 - y^2)}{y^2}, \qquad (5)$$

where b is the polar distance and a is the modulus of the curve. Hence (4) is the equation of a conchoid, which would be obtained by constructing the conchoid of Nicomedes on an extensible surface, and then stretching the surface in the direction of the x axis so that a unit of length becomes $\frac{n}{\sqrt{n^2 - 1}}$, which for water and air is 1.512. These two curves have a common axis, to which they are tangent at an infinite distance, and they also touch each other at the point whose coördidates are $L = 0$, $d = \frac{d''}{n}$.

This furnishes a simple way of constructing the apparent bottom of a sheet of water, of uniform depth d'', as seen from a point whose elevation above the surface is d'. With the point of the eye as a pole, and with the axis in the water surface, draw the superior branch of a conchoid of Nicomedes, making the nodulus $\frac{d''}{n}$. Through any point on this conchoid whose distance from the y axis is L draw a horizontal line, and determine the point on this line whose abscissa is $\frac{n}{\sqrt{n^2 - 1}} L$ (or $1.512\, L$). This is a point on the apparent bottom, and is the apparent position of the point lying directly below upon the real bottom. This determines the direction of any incident and the corresponding refracted ray.

An inspection of the diagram (Fig. 1) led to the discovery of an interesting property of the refraction conchoid. Calling the tangent to this curve at the point just under the eye the *principal* tangent, this property may be stated as follows.

From any point of incidence in the surface, *the distance to the apparent bottom, measured along the incident ray produced, is equal to the distance to the principal tangent measured along the refracted ray.*

Calling these distances s and s', their values are

$$s = \frac{d}{\cos i} \qquad\qquad s' = \frac{d''}{n \cos r}$$

hence

$$\frac{s}{s'} = \frac{dn \cos r}{d'' \cos i}.$$

A reference to eq. (2) shows that the only condition which can satisfy this equation is

$$s = s'.$$

If $s'' =$ the distance of the observed point on the real bottom from the point of incidence, then, as is well known,

$$s'' = ns\ ;$$

which means that light will travel over the distance s'' in the less refracting medium, in the same time required for it to traverse a distance s in the more refracting medium.

2°. To find the shape of the bottom of a pool of water, if it appears plane as seen from any point above the surface.

Let $d'' =$ the apparent depth which is constant;
$d' =$ the height of the eye above the surface;
D and $L =$ the coördinates of any point on the bottom, the origin being in the surface below the eye.

Then, similarly to eq. (2), we have

$$D = nd'' \frac{\cos r}{\cos i}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

which readily takes the form

$$D^2 = n^2 d''^2 \left\{ \frac{1 - \frac{\sin^2 i}{n^2}}{1 - \sin^2 i} \right\} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Substituting for $\sin^2 i$ its value in terms of L, d'' and d', and reducing, the equation readily takes the form

$$\frac{L^2}{\frac{n^2(d'' + d')^2}{n^2 - 1}} - \frac{D^2}{n^2 d''^2} = -1, \quad . \quad . \quad . \quad (8)$$

which is the equation of an hyperbola the semi-axes of which are

$$a = \pm nd'' \qquad b = \pm \frac{n(d''+d')}{\sqrt{n^2 - 1}}$$

The centre of this hyperbola is at our origin of coördinates. The bottom will, of course, be generated by revolving the curve about the vertical line passing through the eye. If the eye is at an infinite height above the surface, the hyperboloid would become a plane, the distance of which below the surface would be

$$D' = nd''.$$

If $n = 1$ the bottom would also be a plane whose depth below the (imagined) surface would be d''. This is shown in the expression for eccentricity, which is

$$e = \sqrt{1 + \left[1 + 2\frac{d'}{d''} + \frac{d'^2}{d''^2}\right] \frac{n^2 - 1}{1}} \quad . \quad . \quad . \quad (9)$$

The conditions which make $e = \infty$, and which would reduce the hyperboloid of revolution to a plane, are $d' = \infty$; $d'' = 0$; or $n = 1$.

The hyperbola would become equilateral if $d' = d''(\sqrt{n^2 - 1} - 1)$, and, in order to comply with the previously assumed conditions, d' and d'' must both be positive, or $\sqrt{n^2 - 1} > 1$, and hence $n > \sqrt{2}$. This condition cannot, therefore, be supplied physically in case of water. The hyperbola would, however, become equilateral for glass ($n = \frac{3}{2}$) if $d' = 0._{118}\, d''$.

With any medium having a refractive index of n, the minimum eccentricity physically possible is (eq. 9)

$$e' = \sqrt{\frac{n^2}{n^2 - 1}}$$

the value of which for water is 1.512.

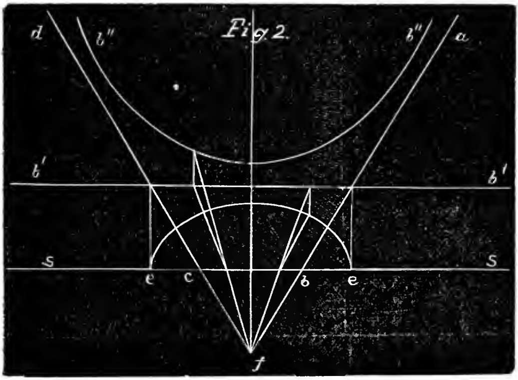
The axes of this hyperbola would be

$$a = \pm\, nd'', \qquad b = \pm \frac{nd''}{\sqrt{n^2 - 1}}$$

If $n = \sqrt{2}$, the equilateral hyperbola would be the limiting case, the eye being in the water surface.

3°. *The eye being in the more refracting medium, it is required to find the surface in the other medium which shall appear plane.*

Let d' = the depth of the eye below the surface;
d'' = distance of the plane from the surface;
D and L = coördinates of any point in the curved surface, the origin being in the water surface above the eye.



EXPLANATION OF CUT.

afd = critical angle cone.
$b''\,b''$ = apparent position of $b'\,b'$ as seen from f.
$b'\,b'$ = apparent position of ee as seen from f, but referring only to the part within the critical angle cone.
ss = water surface.

The angle i being within the more refracting medium, we have

$$D = \frac{\tan i}{\tan r} d'' = \frac{d''}{n} \cdot \frac{\cos r}{\cos i} \quad . \quad . \quad . \quad . \qquad (10)$$

$$= \frac{d''}{n} \sqrt{\frac{1 - \sin^2 r}{1 - \sin^2 i}} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

as $\sin^2 r = n^2 \sin^2 i$ and

$$\sin^2 i = \frac{L^2}{L^2 + (d' + d'')^2}$$

Eq. (11) easily takes the form

$$\frac{D^2}{\frac{d''^2}{n^2}} + \frac{L^2}{\frac{(d' + d'')^2}{n^2 - 1}} = 1 , \quad . \quad . \quad . \quad . \quad . \quad (12)$$

which is the equation of an ellipse whose semi-axes are

$$b = \frac{d''}{n} \qquad\qquad a = \frac{d' + d''}{\sqrt{n^2 - 1}}$$

The eccentricity of this ellipse is

$$e = \sqrt{1 - \left\{1 - \frac{1}{n^2}\right\} \left\{\frac{1}{1 + 2\frac{d'}{d''} + \frac{d'^2}{d''^2}}\right\}} \quad . \quad . \quad (13)$$

The value of e can only become unity if $d' = \infty$, $d'' = 0$, or $n = 1$.

In the first case, the transverse axis of the ellipse becomes infinite, the conjugate axis remaining constant. In the second case, the ellipse reduces to the limited straight line bc, the semi-axes becoming $b = 0$ and $a = \frac{d'}{\sqrt{n^2 - 1}}$, where $\sqrt{n^2 - 1}$ is the cotangent of the critical angle. In the third case, where $n = 1$, since the axes become $a = \infty$ and $b = d''$, the apparent and real positions coincide, or $D = d''$.

The minimum eccentricity physically possible is $\frac{1}{n}$, in which case $d' = 0$ and $a = b \sqrt{\frac{n^2}{n^2 - 1}}$; or for water, for the limiting case, $a = 1.512\, b$.

This ellipse could therefore become a circle only for a substance having $n = \infty$.

The ellipsoid of revolution obtained by revolving the above ellipse about the vertical axis would therefore appear as a horizontal disc exactly filling the cone whose angle is twice the critical angle, the diameter of this disc being equal to the transverse axis of the ellipse.

This discussion also furnishes a simple construction of the incident and refracted rays for any radiant point in the more refracting medium. Supposing the line representing the bounding surface to be horizontal, draw a vertical axis through the radiant point, d' representing its distance below the surface. Select any point in the axis above the surface whose distance from the surface is d''. From this point draw a line parallel to the surface, making its length AB equal to $\frac{d'+d''}{\sqrt{n^2-1}}$. This line will subtend the critical angle, being d'' tan c. From the free end of this line drop a vertical line to the surface, determining thus a point in the surface whose distance from the vertical axis is $a = \frac{d'+d''}{\sqrt{n^2-1}}$. On the vertical axis, lay off from the surface a distance $b = \frac{d''}{n}$. On a and b as semi-axes construct an ellipse. Vertical lines, drawn from any point in the line AB to the ellipse, will determine the direction of any incident and its corresponding refracted ray.

4°. To find the apparent form of a horizontal plane in a less refracting medium, as viewed from a point in a more refracting medium, the refracting surface being supposed horizontal.

Let d'' = the constant distance between the plane and the refracting surface;
d' = distance from the eye to the surface;
d and L = coördinates of any point in the apparent surface:

then
$$\sin i = \frac{1}{n} \cdot \sin r.$$

$$d = n \cdot \frac{\cos i}{\cos r} \cdot d'' = nd'' \sqrt{\frac{1-\sin^2 i}{1-n^2 \sin^2 i}}$$

and as
$$\sin^2 i = \frac{L^2}{L^2 + (d'+d)^2}$$

we have finally
$$L^2(1-n^2) = \frac{(d'+d)^2\,(n^2 d''^2 - d^2)}{d^2} \quad . \quad . \quad (13)$$

which is an equation of the fourth degree and of the same general form as the equation of the former refraction conchoid in the first problem. It cannot be referred to the conchoid of Nicomedes by projection along the x axis, as the projection factor $\sqrt{\frac{1}{1-n^2}}$ is imaginary. The form of the curve is shown in Fig. 2. It of course lies wholly within the critical angle, and the surface of revotution will lie within the cone whose apex is at the eye, and having an angle of twice the critical angle, to whichit is asymptotic. The surface will be a frustum of the critical angle cone when the plane is in the less refracting medium, but at the refracting surface. The equation of the curve (13) then becomes

$$d = -d' \pm \sqrt{n^2 - 1}\, L\,.$$

This equation fails for that part of the plane within the cone. A complete solution is however furnished by the polar equation, which is

$$\rho = d' \sec i + \frac{d''}{\sqrt{\frac{1}{n^2} - \sin^2 i}} \quad . \quad . \quad . \quad (14)$$

If $d'' = 0$, then for all values of i between 0° and the critical angle (14) becomes

$$\rho = d' \sec i + 0\,. \quad . \quad . \quad . \quad . \quad . \quad (15)$$

If $i =$ the critical angle, sin i becomes $\frac{1}{n}$ and (14) becomes

$$\rho = d' \sec i + \frac{0}{0}\,. \quad . \quad . \quad . \quad . \quad . \quad (16)$$

If $i >$ the critical angle, ρ becomes imaginary. When $d'' = 0$ eq. (14) is therefore the equation of the broken line $a\ b\ c\ d$ of Fig. 2, which is the envelope of all curves for which $d'' > 0$.

The results here reached are, of course, simple consequences of well known relations, but it seems that the constructions involved have not received the attention which they deserve.

The additional fact that many lives are doubtless lost every year by reason of these deceptive appearances is, perhaps, a sufficient warrant for the publication of this discussion.

Magnetic Determinations in Missouri during the Summer of 1880.

By FRANCIS E. NIPHER.

In the previous number of the Transactions* we have given a report on magnetic work done in 1878 and 1879. The work of these years was mainly confined to the northern and western parts of the State. In 1880 the work was carried into south-east Missouri. Advantage was taken of trips to adjoining States to make determinations there.

Following is a description of stations where observations have been made. A much fuller description, with sketches and plat of the ground on which the determinations were made, is in the possession of the writer. The numbers of the stations are continued from previous reports.

STATION 32 *b*— *Collinsville, Madison Co., Ills.* Observations in the north corner of the yard (orchard) of O. B. Wilson. The schoolhouse spire bears S. 76° 30'.$_8$ W. The Collinsville work was repeated at a different station from that of 1879, as, according to the work of last year, the declination at Collinsville and at Washington (60 miles W.) was nearly the same. The redetermination confirmed this result. It was further confirmed by the subsequent work of the summer. Polaris observation for meridian. At this station only the morning-mark reading was obtained.

STATION 18 *d—Iowa City, Iowa.* On farm of Peter Nipher, in the meadow 90 yds. S. of the S.E. corner of the house. Polaris obs.

STATION 18 *c* — the same station as that of 1879. The mark of 1879 was used.

STATION 33 — *near Atalissa, Muscatine Co., Iowa.* Lat. 41° 38'.$_4$;† Lon. 91° 13'.$_8$. On the farm of Mrs. Grace Aikins, on the N.E. qr. of the N.E. qr. of sec. 2, tp. 78 N., r. 3 W. of the 5th prin. merid. In a small slough a little W. of the house and midway between the house and the Cedar Co. line. No evening mark reading.

STATION 34 — *in Cedar Co., Iowa.* Lat. 41° 42'.$_7$; Lon. 91° 14.'$_0$. On farm of Edmund Aikins, near the N.E. corner of S.E. qr. of sec. 20, tp. 79, r. 3 W. In yard 70 ft. S. of the house and 50 from the road fence. This station is marked by a sandstone set about 24 inches into the ground,

* Trans. Acad. Sci. of St. Louis, vol. iv. No. 1, pp. 81-101, 121-145.

† These latitudes and longitudes have been determined by the Land Office map, as was explained in the first report. This has been criticised in a semi-public way It is only necessary to state that the writer does not consider this an accurate method of determining latitude; but that it is sufficiently so for this magnetic survey is a matter which does not admit of discussion.

with the upper face (into which a cross is cut) level with the ground. Polaris obs.

STATION 35—*Cedar Co., Iowa.* Lat. 41° 42′.$_7$; Lon. 91° 14′.$_2$. Farm of Philo Mead, and near the centre of the S.W. qr. of sec. 25, tp. 79, r. 4 W. About 250 ft. S. of the house and in the prolongation of the front drive just where it curves eastward. Polaris obs.

STATION 36—*near Atalissa, Muscatine Co., Iowa.* Lat 41° 38′.$_4$; Lon. 91° 13′.$_8$. About 60 rods N. of the centre of sec. 2, tp. 78, r. 3. W. About 60 yds. from the road. Observations in a cornfield, 50 rods N. of the house of John Cope. Polaris obs.*

STATION 37—*Lutesville, Bollinger Co., Mo.* Lat. 37° 20′.$_0$; Lon. 89° 58′.$_8$. On the crest of the hill S. of town on open common. The schoolhouse (S.W. corner) lies 200 ft. nearly due E. and the Greenville road lie. W. 100 ft. The first star observation was spoiled by rain; the second was successful, but a morning fog prevented a morning reading of the marks A sun observation (equal altitudes) was also taken, but the first mark reading was forgotten in the hurry of work. The two observations differed 0′.$_8$, and were given equal weight.

STATION 38—*Charleston, Mississippi Co., Mo.* Lat. 36° 55′.$_8$; Lon. 89° 19′.$_2$. In the yard of the Fletcher House, 140 ft. N. of the N.W. corner of the building. Polaris obs.

STATION 39—*Poplar Bluffs. Butler Co., Mo.* Lat. 36° 44′.$_4$; Lon. 90° 21′.$_6$. In a vacant lot on the crest of the hill in front of the house of S. M. Chapman. The centre of the court house dome bears S. 42° 13′.$_9$ W., and the S.W. corner of Mr. Chapman's house bears N. 5° 32′.$_7$ E. Polaris obs.

STATION 40 *a—Doniphan, Ripley Co., Mo.* Lat. 36° 37′.$_8$; Lon. 90° 46′.$_8$. In the court-house yard. 15 ft. from the E. fence and 18 ft. from the S. fence. Polaris obs. for meridian. The magnetic meridian was determined by a single reading of the magnetic axis at 7:19 A.M., and intensity was determined by oscillating magnet C_6 in Declin. No. 3. This determination was reduced to absolute measure by calculating the magnetic moment for that day from the formula expressing its value for successive days, as deduced from the work of the summer. The magnet was oscillated in Declinometer No. 3. with the new leveling screw as used in 1879. This station was reached by wagon from Poplar Bluffs. and the roads were so heavy that we were obliged to leave behind all our instruments excepting Declin. No. 3.

STATION 40 *b — Doniphan.* This station was 50 ft W. of S. from the previous station and in line of the mark. A single declination reading was taken at 8:15 A.M. as a check on the previous determination.

* In all observations thus far made the instrument was covered by a cloth, as we had no tent. The instrument used was Declinator No. 1 and Magnet C_6, arranged as in 1879. See Trans. iv. 1, p. 134. Unless otherwise stated, intensity observations were hereafter made with the University Magnetometer.

STATION 41 — *Gatewood, Ripley Co., Mo.* Lat. 36° 31'.$_8$; Lon. 91° 03'.$_0$. N.W. qr. of N.W. qr. of sec. 8, tp. 22, r. 1 W. of 5th pr. meridian, on the farm of J. F Oneal. The observations were made in the front yard, midway between the house and the fence. The observations were made and reduced precisely as at Doniphan.

STATION 42 *a — Piedmont, Wayne Co., Mo.* Lat. 37° 08'.$_4$; Lon. 90° 41'.$_4$. Station W. of the yard of Dr. Pettit, and 42 ft. from the middle of the garden fence, near the edge of the timber. Complete determinations made here. Meridian by polaris obs.

While reading the magnet scale in the first declination observation, two trees, one 110 ft., the other 210 ft. distant were simultaneously struck by lightning. A stinging spark passed from the telescope to the observer's head, but the needle was not visibly affected.

Up to this determination the declination magnet had been suspended on a bundle of silk floss, which had first been rendered permanent by a long suspension of the torsion weight. As it had been necessary to break this fibre at Poplar Bluffs in order to exchange stirrups, the first Piedmont declination was not very satisfactory, as the newly tied fibre developed 90° of twist during the day. Assuming no error in the morning elongation, this would make a correction of — 7'.$_6$ on the declination. The floss was replaced by a single fibre in all subsequent work.

STATION 42 *b—Piedmont.* Station 270 ft. nearly due N. of station "*a*." A check determination of declination was made here, the magnetic meridian being determined by a single reading of the axis of magnet No. 1 at 3:35 P.M. The true meridian was deduced from station "*a*."

STATION 43 *a—Arcadia, Iron Co., Mo.* Lat. 37° 46'.$_2$; Lon. 90° 40'.$_8$. Observations in the garden of the hotel, on the walk midway between the spring and the front gate. The triangulation station on Pilot Knob bears N. 3° 42'.$_7$ E. In this region local influence is very great, and the best average value for declination is deduced from the determinations of J. Pumpelly and P. N. Moore in 1872. Several hundred determinations gave them 7° 30'. Assuming an annual decrease of 2', this would give for 1879 a declination of 7° 16'.

A polaris observation was made here, but some unknown error amounting to several degrees occurred in the work. The meridian was deduced from observation at the next station, and the result thus obtained was afterwards checked by a polaris observation made about an hour before elongation.

STATION 43 *b*—base of *Pilot Knob*, at the N.W. end of the triangulation base line. This station is about at the vertex of an equilateral triangle, the other vertices of which are at the extremities of the N.E. side of the old fort. It is marked by a large limestone rock one foot below the surface of the ground. A drill-hole in this rock is filled with lead, in which is cut a cross. From this station, the station on the summit of Pilot Knob bears S. 82° 58'.$_9$ E. A single reading of the magnetic axis was taken at 1:49 P.M. of the 19th.

A solar compass determination of declination was made here by Pumpelly and Moore in 1872, the resulting value being 11° 30′. A polaris observation was made here. Mr. J. de Goncer. engineer for the Pilot Knob Iron Co., made the transit observations for oscillation, in a most efficient manner.

STATION 43 *c*—Top of *Pilot Knob*. This station was also occupied by Pumpelly and Moore, their value for declination being 4° 30′ E. The station is marked by a drill-hole cut into the porphyry, at the centre of a white cross which is painted on the rock. Observations on this cap rock, which overlays the hematite, show that it is filled with magnetic poles within a few inches of each other, and sufficiently strong to reverse the position of the needle of a pocket compass. When raised upon the tripod, Pumpelly and Moore found the deviation from the normal direction to be on the average 2° to 3°, and the greatest deviation from the normal value in the Pilot Knob region was 7° 30′ to 8°. In our determination the needle was 50 inches above the face of the rock. The meridian here was deduced from the observations at station "*b*."

STATION 44 *a*—*De Soto, Jefferson Co., Mo.* Lat. 38° 06′.$_6$; Lon. 90° 34′.$_8$. On the crest of the hill almost due W. of the railway depot. The meridian was determined by a sun observation. The result of the declination determination gave a value greater than was expected by more than a degree. The result obtained the next day was 12′ more. The reason for this difference is not known, although it is known that it was not an error in reading, and there was no part of the work which did not seem satisfactory excepting perhaps the sun observations, and this does not account for the difference, which was due to a change in the determination of magnetic meridian. The record of the sun observations was made by Mr. Jno. L. Downer of De Soto, in the absence of Mr. Woodward. Mr. Downer also made the telescopic determinations in the oscillation series. The declination determination having been unsatisfactory here, it was repeated at

STATION 44 *b*, which is about a mile E. of the former, on the farm of Chas. Fitch, not far from the middle of the N. line of the S.W. qr. of sec. 1, tp. 39, r. 4 E. Observations made in the edge of the meadow N.E. of the house. Polaris observation.

STATION 45—*Kimmswick, Jefferson County, Mo.* Lat. 38° 19′.$_8$; Lon. 90° 25′.$_8$. On the grounds of the Montesano Springs Co., 250 ft. from the south road fence, and 525 ft. S.W. of the S.W. corner of the hotel. Sun observations.

STATION 46—*Pacific, Franklin Co., Mo.* Lat. 38° 28′.$_2$; Lon. 90° 43′.$_8$. Observations 1250 ft. N. of the depot, and 95 ft. and 180 ft. from the E. and W. elms, and 135 ft. from the oak, all large trees standing alone. Sun observations.

In this region the declination changes very rapidly to the S.

At the next station the sustaining fibre was found to be frayed and in contact with the glass tube. This probably accounts for a very irregular oscillation series which was first made. A second series gave a somewhat better result. The source of the trouble was not discovered at the time. For this station, therefore, the oscillation and deflection series were reduced independently as relative determinations, and reduced to absolute measure by calculating the value of m for that day as explained under station 40.

STATION 47—*Cuba, Crawford Co., Mo.* Lat. 38° 03'.$_6$; Lon. 91° 21'.$_0$. Station in the road in front of the schoolhouse and 125 ft. distant. Sun observation for meridian.

STATION 48 *a*—*Salem, Dent Co., Mo.* Lat. 37° 39'.$_0$; Lon. 91° 30'.$_6$. In the meadow of Dr. J. N. McMurtrie, a few yards N. of the barn and just N. of the shallow slough. The S.E. corner of the court-house bears S. 42° 59'.$_4$ W. The meridian was determined by a pole-star observation. As the declination was over half a degree less than was expected, the meridian determination was checked by a sun observation. No error being detected here, observations for magnetic meridian were made at the two following stations.

STATION 48 *b*—On the hill 420 ft. N.E. of station "*a*." The true meridian was deduced from station "*a*," and the magnetic meridian was determined by a single reading of the axis of C_6 at 5:20 o'clock P.M.

STATION 48 *c*—About 500 ft. nearly N. of station "*a*." Observations made at 5:40 P.M. as before.

The observations all agreed very well, nevertheless it seemed probable that the unexpected result was due to local causes, and not much weight was given to the observations until a conversation with Prof. Emerson, of the Rolla School of Mines, brought out the fact that the declination at Rolla is practically the same as at Salem. This established the existence of the looped area of minimum declination shown on the map, and also explained fully the anomalous result at De Soto. Subsequent determinations at Houston were also confirmatory. It is to be remarked that the western iron field in Missouri (which lies *chiefly* in the triangle whose vertices are at Rolla, Cuba, and Salem) is partly coincident with this area of minimum declination. To what extent the iron deposits (chiefly specular ore in sandstone) are the cause of this minimum area, is a question which requires further attention. It should be stated that no iron is known to exist in the immediate vicinity of the stations of observation.

STATION 49—*Houston, Texas Co., Mo.* Lat. 37° 19'.$_2$; Lon. 91° 55'.$_2$. This station and the following one were reached by wagon from Salem. Only relative intensity determinations were made here, magnet C_6 being oscillated in Declinom. No. 3. The absolute value was calculated as explained under station 40. The observations were made in the front yard of the Texas House, 25 ft. from the W. fence and 68 ft. from the line of the N. side of the house.

STATION 50—*Howell Co., Mo.* Lat. 36° 56′.₀; Lon. 91° 55′.₂. This station is on the farm of Thomas Pottles, which is on the N.E. qr. of the N.E. qr. of sec. 16, tp. 26, r. 9 W. of 5th pr. meridian. The house is situated just at the base of the hill and at the junction of the Houston and Salem roads. The observations were made 23 ft. N. and 25 ft. W. of the N.W. corner of the (log) house. The determinations were made in the same manner as at Houston.

STATION 51—*Beardstown, Cass Co., Ills.* Lat. 40° 00′; Lon. 90° 29′.₀. Complete observations were made on the N. side of Main st. at its intersection with Adams st. and a few rods from the shore of the Illinois river. Pole-star observation.

At this station on the 9th of August, beginning at 7:20 o'clock A.M., a remarkable disturbance was noted. Between 7:20 and 7:35 the easterly variation increased 7′.₂, and by 7:49 it had diminished an equal amount. At this time the needle did not oscillate over a greater arc than 0′.₅, and the single fibre of silk on which the needle was suspended had been used since July 28, so that no part of this disturbance could have been due to torsion. The needle could at times be seen to move, and eight readings were taken during the disturbance.

This disturbance does not seem to have been noticed elsewhere, although they were generally observed on the 11th.

STATION 52—*New Athens, St. Clair Co., Ills.* Lat. 36° 10′.₈; Lon. 89° 55′.₄. Observations were made in order to locate the 6° line, which enters S.E. Missouri at some point not yet accurately determined. Observations were made on a vacant lot owned by Aug. Kirchner, and distant 50 ft. from the W. fence on Kaskaskia st. and 80 ft. from the N. fence. Polaris observation at *western* elongation. No evening mark reading.

STATION 53—*O'Fallon, St. Charles Co., Mo.* Lat. 38° 46′.₈; Lon. 90° 43′.₂. In the yard of Dr. W. C. Williams, 52 ft. from the front fence and 52 ft. from the line of the S. side of the house. A polaris observation was made at eastern and also at western elongation. Intensity was determined by an oscillation series with C_6 in Declin. No. 3, in which Prof. H. S. Pritchett, of Morrison Observatory, observed the magnet scale, the watch being read by myself. The moment of C_6 was calculated for Aug. 9th, although the observations were made Oct. 31, as the magnet remains quite constant when not in use, as is shown by the determinations of 1879 and 1880.

STATION 54—*Rolla, Phelps Co., Mo.* Lat. 37° 57′.₆; Lon. 91° 45′.₀. The observations at this station were made by Prof. Emerson, of the Rolla School of Mines. The instrument used was a solar compass. The observations were made in the spring of 1880 and were continued over 8 or 9 days, observations having been made at 6 and 9 A.M., 12 M., and 3 and 5 P.M. The mean value is given as 6° 53′, which agrees very well with the Salem observations. The true meridian was determined four or five years ago by observation of Polaris on elongation, and has been re-examined each year in the regular work of instruction.

In the former report it was mentioned that the brass-work of Declin. No. 3 U. S. C. S. contained iron, and the correction to be applied in intensity determinations was given.* It remained to determine the effect of the brass-work upon the position of the needle. For this purpose the magnet box was clamped in such a position that the brass-work could be put on and removed without disturbing the needle. The brass pieces were then put on separately and the effect of each piece noted. As the positions of the side screws which fasten the doors of the box were not changed during the summer, the correction to be applied is easily obtained. It was also important to determine whether the change of the leveling screws in leveling up the instrument had any effect. To determine this, the plates carrying the screws were first put in place, with the screws down to the lowest limit, and they were then screwed up into position. The results with magnet C_6 are given below.

Simultaneous readings of magnet No. 1 were made, this magnet being suspended in the University magnetometer, and C_6 was corrected for hourly change. Two series first made gave discordant results, which were traced to torsion effects in a new silk fibre used for suspension of C_6. After the magnet had been suspended for 24 hours, the fibre became quite constant. The means for six careful and closely agreeing determinations are given.

Effect of magnetic brass-work of Declinometer No. 3 on Magnet C_6.

Scale value $2._{35}$.

	Scale.	Change
All brass away	84.0	
Leveling screws on, but down	83.8	0′.5
Leveling screws up in place	84.0	0 .0
+ Mirror and support	83.9	0 .2
+ Side screws, all brass on	83.0	2 .3

* Page 134, vol. iv. No. 1, of these Transactions.

It will be observed that changing the leveling screws to the utmost limit, which is about one inch, changes the position of the needle half a minute. As we have always taken the precaution to level up the tripod with a good hand level, the leveling screws were not changed sufficiently to introduce any appreciable error. The effect of the side screws turns out to be the most serious, and the effect of all the brass-work is to diminish the easterly declination $2'._3$, and this quantity is *added* to all determinations where magnet C_6 was used during 1880. Previous to that time no correction can be made, as was explained in the former report (*loc. cit.*)

A similar determination was made with magnet No. 1 in Decl. No. 3, correction being also made for hourly change. Seven determinations showed that the effect of the brass-work of Decl. 3 upon magnet No. 1, is to throw the magnet to the west $1._{04}$ scale divisions, or $1'._{97}$. The observed declinations made with magnet No. 1 in Declinometer No. 3, for 1880, have therefore received a correction of $+2'._0$.

INTENSITY.

The observations of the summer were made in the same manner as before, excepting that we found it of great advantage to read watch time, by observing the second-hand with a good pocket lens. The watch lost $2._4$ seconds per day during the summer, and correction for rate was therefore omitted.

The temperature constant q was taken as $0._{00048}$, as determined in 1878.*

The following table gives the calculation of the value of P for the summer.

* Trans. vol. iv. No. 1, pp. 88–90.

Summer of 1880. — Determination of P.

Station.	Date.	LOGARITHMS. $r^3 \tan u$.	$r^3 \tan u'$.	$r \tan u$.	$r' \tan u'$.	A.	B.	$\frac{A}{B}$	P.
Lutesville.........	July 6	9.47319	9.47295	8.87113	8.98688	6.23045 *p*	8.35599 *n*	7.87446 *n*	— 0.0075
Charleston........	" 8	9.47257	9.47241	8.87051	8.98634	6.07918 *p*	8.35576 *n*	7.72342 *n*	— 0.0053
Poplar Bluffs.....	" 10	9.46680	9.46683	8.86474	8.98076	5.30103 *n*	8.35079 *n*	6.95024 *p*	+ 0.0009
Piedmont.........	" 16	9.47116	9.47203	8.86910	8.98596	6.77085 *n*	8.35872 *n*	8.41213 *p*	+ 0.0258
De Soto	" 21	9.48894	9.48795	8.88688	9.00188	6.85126 *p*	8.36847 *n*	8.48279 *n*	— 0.0303
Pacific	" 27	9.49362	9.49413	8.89156	9.00806	6.55630 *n*	8.37967 *n*	8.17663 *p*	+ 0.0150
Cuba................	" 28	9.47801	9.47513	8.87595	8.98906	7.29667 *p*	8.34945 *n*	8.94722 *n*	— 0.0886
Salem	" 29	9.47314	9.47231	8.87108	8.98624	6.78533 *p*	8.35344 *n*	8.43189 *n*	— 0.0270
Beardstown	Aug. 9	9.51631	9.51582	8.91425	9.02975	6.57978 *p*	8.39808 *n*	8.18170 *n*	— 0.0152

The mean of the values P is -0.0147, and hence the special values of $\log\left(1 - \frac{P}{r^2}\right)$ for the two values of r become

r	$\log\left(1 - \frac{P}{r^2}\right)$
1.75	0.00208
2.00	0.00161 ,

which values have been used in the reduction of all deflection series.

The following table gives the reduction of the magnetic moment of C_6 for 1880.

Magnetic Moment of C_6 for 1880.

Date.	t.	$t-90.3$	log $1+(t-90.3)q$.	$\log m_t$.	$\log m$.	Days.	d.	$y = \log m_0 - \log m$	yd.	d_2.
July 6	89.1	−1.2	0.00025	9.86924	9.86949	0	−15	−0.00084	+0.01260	225
" 8	90.6	+0.3	9.99991	9.86775	9.86766	2	−13	+99	−0.01289	169
" 10	94.1	+3.8	9.99921	9.86888	9.86809	4	−11	+56	−0.00616	121
" 16	89.0	−1.3	0.00027	9.87173	9.87200	10	−5	−335	+0.01675	25
" 21	80.9	−9.4	0.00192	9.86948	9.87140	15	0	−275	0.00000	0
" 28	95.5	+5.2	9.99891	9.86640	9.86531	22	+7	+334	+0.02338	49
" 29	91.7	+1.4	9.99970	9.86844	9.86814	23	+8	+51	+0.00408	64
" 29	91.7	+1.4	9.99970	9.86831	9.86801	23	+8	+64	+0.00512	64
Aug. 9	90.5	+0.2	9.99995	9.86776	9.86771	24	+19	+94	+0.01786	361
Mean	90.3			$m_0 =$	9.86865	14.8		Σ	+0.07074	1078

Hence the daily decrease in the value of log m is

$$a = + \frac{\Sigma(yd)}{\Sigma d^2} = \frac{0.07074}{1078} = 0.000065,$$

and at a temperature of $90._3$ for the series

$$\log m = 9.865 - 0.000065\, d,$$

where d is estimated from July 21st.

The following tables comprise the observations made. In the first table are given the meridian determinations by the method of equal altitudes of the sun, in which t represents half the sidereal interval between the morning and afternoon series, $\frac{1}{2}(A+A')$ is the uncorrected reading of south, while e represents the probable error of $\frac{1}{2}(A+A')$, treating this quantity as constant. Δd is the increase in solar declination during the time $2t$.

Sun Observations for Meridian.

Station.	Date.	No. of Obs.	t.	$\frac{1}{2}(A+A')$.	e.	log Δd.	Cor.	South reads	Mark reads	Azim. mark.
Lutesville..	July 6	13	41° 16'.3	328° 26'.7	0'.07	0.15229	+1.3	328° 28'.0	176° 57'.7	S. 151° 30.3 E.
De Soto....	" 22	9	42 16 .1	32 18 .9	0 .08	0.45332	2.7	32 21 .6	180 01 .1	S. 147 39.5 W.
Kimmswick	" 24	10	44 01 .6	200 01 .8	0 .09	0.49554	2.9	200 03 .7	180 01 .9	S. 20 01.8 E.
Pacific......	" 27	9	43 28 .7	139 33 .3	0 .06	0.52114	3.1	139 36 .4	180 00 .6	S. 40 24.2 W.
Cuba..	" 28	10	44 50 .1	255 51 .6	0 .14	0.54531	3.2	255 54 .8	180 01 .4	S. 75 53.4 W.

Magnetic Declination or "Variation.

STATIONS.	MAGNET SCALE.					AZIMUTH CIRCLE.				DECLINATION.		Date.
	Elongations. East.	Elongations. West.	Mean.	Axis reads.	Reduction to Axis.	Circle reads.	Magnetic South reads.	Mark reads.	True South reads.	Uncorrected.	Corrected.	
Collinsville, Ills., *b*	82d.0	72d.9	77d.45	80d.36	−5′.5	110°00′.7	109°55′.2	179°58′.0	103°27′.1	6°28′.1	6°30′.4	May 22
Iowa City, *d*	82 .3	76 .8	79 .55	76 .31	+7 .6	174 27 .0	174 34 .6	180 01 .7	165 48 .7	8 45 .9	8 48 .2	June 16
" "	81 .0	77 .7	79 .35	[76 .31]	+7 .1	174 26 .7	174 33 .8	180 01 .4	165 48 .4	8 45 .4	8 47 .7	17
" *c*	79 .6	75 .2	77 .40	[76 .31]	+2 .6	303 43 .7	303 46 .3	180 01 .1	294 56 .2	8 50 .1	8 52 .4	18
" "	81 .1	76 .1	78 .60	[76 .31]	+5 .4	303 39 .0	303 44 .4	180 00 .9	294 56 .0	8 48 .4	8 50 .7	19
" "	80 .0	74 .8	77 .40	[76 .31]	+2 .6	303 41 .2	303 43 .8	190 01 .1	294 56 .2	8 47 .6	8 49 .9	20
Atalissa, Ia., St. 33	81 .0	74 .7	77 .85	[76 .31]	+3 .6	97 37 .7	97 41 .3	180 00 .5	90 25 .3	7 16 .0	7 18 .3	24
Cedar Co., " " 34	81 .4	75 .0	78 .20	76 .30	+4 .5	187 32 .7	187 37 .2	180 01 .1	179 41 .9	7 55 .3	7 57 .6	26
" " " "	......	......	......	[76 .30]	−7 .0	187 44 .5	187 37 .5	180 01 .1	179 41 .9	7 55 .6	7 57 .9	27
" " " 35	79 .25	75 .0	77 .12	[76 .30]	+1 .9	187 01 .2	187 03 .1	180 01 .6	179 40 .4	7 22 .7	7 25 .0	28
Atalissa, " " 36	80 .2	76 .8	78 .50	[76 .30]	+5 .1	89 11 .5	89 16 .6	180 01 .4	82 12 .8	7 03 .8	7 06 .1	30
Lutesville, Mo.	80 .3	76 .0	78 .15	79 .91	−3 .3	334 42 .7	334 39 .4	176 57 .7	328 28 .4	6 11 .0	6 13 .0*	July 6
" "	81 .85	77 .1	79 .47	[79 .91]	−0 .8	337 45 .0	337 44 .2	180 00 .7	331 31 .4	6 12 .8	6 14 .8*	7
Charleston	82 .4	76 .2	79 .30	78 .92	+0 .7	111 00 .0	111 00 .7	180 00 .4	105 19 .5	5 41 .2	5 43 .2*	8
Poplar Bluffs	81 .1	77 .3	79 .20	78 .85	+0 .6	155 39 .2	155 39 .8	180 01 .2	148 57 .1	6 42 .7	6 44 .7*	10
Doniphan, *a*	......	......	......	76 .75	−7 .0	177 10 .5	177 04 .0	0 00 .7	170 01 .2	7 01 .8	7 04 .1	12
" *b*	.....	......	......	....	−6 .5	177 10 .5	177 03 .5	0 00 .7	170 01 .2	7 02 .8	7 05 .1	12
Gatewood	......	......	......	76 .75	−7 .0	92 34 .7	92 27 .7	179 59 .5	85 18 .2	7 09 .5	7 11 .8	13

Piedmont, *a*	78d.5	84d.5	81d.00	78d.85	+4′.1	241°59′.5	242°03′.6	180°01′.5	234°33′.9	7°29′.7	7°31′.9*	July 15
" "	81 .2	75 .9	78 .55	[78 .85]	−0 .7	241 50 .2	241 49 .5	180 00 .7	234 33 .1	7 16 .4	7 18 .4*	16
" *b*	......	......	.....	[78 .85]	+4 .0	260 30 .5	260 34 .5	180 00 .0	253 18 .1	7 16 .3	7 18 .3*	16
Arcadia, *a*	79 .65	76 .40	78 .02	76 .75	+3 .0	356 13 .2	356 16 .2	184 01 .5	349 29 .8	6 46 .4	6 48 .7	17
Pilot Knob, *b*	......	......	......	76 .75	0 .0	274 06 .5	274 06 .5	180 01 .5	263 00 .4	11 06 .1	11 8 .4	19
" *c*	76 .8	73 .6	75 .20	[76 .75]	−3 .6	86 46 .2	86 42 .6	480 00 .6	82 59 .5	3 43 .1	3 45 .4	20
De Soto, *a*	83 .0	75 .6	79 .30	78 .16	+2 .1	40 63 .7	40 05 .8	180 01 .9	32 22 .4	7 43 .4	7 45 .4*	21
" "	80 .4	75 .7	78 .05	77 .47	+1 .4	40 16 .3	40 17 .7	180 01 .2	32 21 .8	7 56 .4	7 58 .7	22
" *b*	80 .0	75 .75	77 .87	[77 .47]	+0 .9	232 40 .0	232 40 .9	179 59 .7	225 06 .7	7 34 .2	7 36 .5	23
Kimmswick	79 .5	74 .9	77 .20	[77 .47]	− 0 .6	206 47 .5	206 46 .9	180 01 .9	200 03 .7	6 43 .2	6 45 .5	24
Pacific	80 .7	74 .5	77 .60	78 .26	−1 .3	146 38 .2	146 36 .9	180 01 .0	439 36 .8	7 00 .1	7 02 .1*	27
Cuba	80 .6	74 .5	77 .55	77 .90	−0 .8	263 17 .7	263 16 .9	180 00 .7	255 54 .1	7 22 .8	7 24 .8*	28
Salem, *a*	79 .7	74 .3	77 .00	77 .51	− 1 .2	143 53 .7	143 52 .5	180 00 .2	136 59 .9	6 52 .6	6 54 .9	30
" *b*	.....	......	......	[77 .51]	+2 .0	137 26 .7	137 28 .7	180 00 .7	130 31 .4	6 57 .3	6 59 .6	30
" *c*	.....	.....	......	[77 .51]	+2 .0	147 40 .7	147 42 .7	180 00 .7	140 50 .6	6 52 .1	6 54 .4	30
Houston	79 .5	75 .4	77 .45	77 .24	+0 .5	79 10 .5	79 11 .0	180 00 .7	71 38 .4	7 32 .6	7 34 .9	Aug. 1
Howell Co., St. 50..	80 .4	75 .3	77 .85	77 .29	+1 .3	172 16 .5	172 17 .8	180 00 .7	164 48 .8	7 29 .0	7 31 .3	3
Beardstown, Ills. ...	84 .35	73 .1	78 .72	78 .01	+1 .5	124 59 .2	125 00 .7	180 00 .7	118 17 .1	6 43 .6	6 45 .6*	9
" " ...	80 .5	74 .0	77 .25	[78 .01]	− 1 .5	124 57 .7	124 56 .2	180 00 .5	118 16 .9	6 39 .3	6 41 .3*	10
New Athens, " ...	80 .3	75 .5	77 .90	76 .96	+2 .2	189 20 .0	189 22 .2	180 00 .1	183 35 .4	5 46 .8	5 49 .1	Oct. 9
O'Fallon, Mo.	80 .2	78 .2	79 .20	77 .25	+4 .6	239 06 .0	239 10 .6	180 00 .7	232 27 .5	6 43 .1	6 45 .4	30

* Magnet No. 1 was used; at other stations C_6 was used.

Polaris Observations for Meridian.

Station.	Date.	Azim. Circle. Vernier A. Mark reads	Azim. Circle. Vernier A. Polaris reads	Azimuth of Elongation	North reads	Azimuth of Mark.	Remarks.
Colllinsville, *b*	May 22	74° 48′.0	179° 59′.2	1° 42′.4	178° 17′.1	S. 76°30′.9 W.	No tent.
Iowa City, *d*	June 15	180 00 .5	347 34 .5	1 47 .0	345 47 .5	" 14 13 .0 "	"
Atalissa, Ia. (33)	" 24	112 06 .7	204 18 .5	1 47 .0	202 31 .5	" 89 35 .2 "	"
Cedar Co., Ia. (34)	" 25	180 00 .7	1 28 .5	1 47 .0	359 41 .5	" 0 19 .2 "	"
" " (35)	" 27	180 01 .9	1 27 .7	1 47 .0	359 40 .7	" 0 21 .2 "	"
Atalissa. Ia. (36)	" 30	179 59 .3	263 57 .7	1 47 .0	262 10 .7	" 97 48 .6 "	"
Lutesville	July 5	180 00 .5	153 12 .2	1 40 .5	151 31 .7	" 151 31 .2 E.	See sun observation.
Charleston	" 8	180 00 .2	286 59 .5	1 40 .2	285 19 .3	" 74 40 .9 W.	
Poplar Bluffs	" 10	180 00 .9	330 36 .7	1 39 .9	328 56 .8	" 31 04 .1 "	
Doniphan	" 12	180 00 .5	171 40 .7	1 39 .7	170 01 .0	" 170 00 .5 E.	
Gatewood	" 13	180 00 .1	266 58 .5	1 39 .7	265 18 .8	" 94 41 .3 W.	
Piedmont	" 15	179 59 .2	56 12 .0	1 40 .4	54 31 .6	" 54 32 .4 E.	
Pilot Knob, *b*	" 18	180 03 .2	84 43 .2	1 41 .1	83 02 .1	" 82 58 .9 "	No tent.
De Soto, *b*	" 22	180 00 .0	46 48 .7	1 41 .7	45 07 .0	" 45 07 .0 "	
Salem	" 30	180 00 .9	318 41 .7	1 41 .1	317 00 .6	" 43 00 .3 W.	
Houston	Aug. 1	180 00 .5	253 18 .7	1 40 .5	251 38 .2	" 108 22 .3 "	
Howell Co.	" 3	180 00 .7	346 28 .5	1 39 .7	344 48 .8	" 15 11 .9 "	
Beardstown	" 9	180 00 .2	299 59 .8	1 44 .1	298 15 .7	" 61 43 .6 "	
New Athens, Ills	Oct. 9	354 51 .7	176 45 .2	1 41 .8	178 27 .0	" 3 35 .3 E.	Polaris on W. elongation.
O'Fallon, Mo.	" 30	180 00 .7	234 10 .7 230 44 .2	1 42 .5	232 27 .5	" 52 26 .8 "	" E. and W. elong.

Intensity — Oscillations.

STATION.	Date.	t'. Temp.	LOGARITHMS. T'^2.	$1+\frac{h}{f}$	$1-(t'-t)q$	T^2.	k.	mH.	H.	H.
Lutesville	July 6	87°2	1.65244	0.00035	0.00040	1.65319	1.22349	0.56460	0.69536	4.959
Charleston	" 8	91.2	1.65536	0.00041	9.99991	1.65568	1.22355	0.56217	0.69442	4.948
Poplar Bluffs	" 10	96.2	1.64783	0.00039	9.99956	1.64778	1.22362	0.57014	0.70126	5.026
Doniphan	" 12	91.0	1.64754	0.00154	9.99964	1.64872	1.22355	0.56913	0.69989	5.011
Gatewood	" 13	91.3	1.64654	0.00148	9.99979	1.64781	2.22356	0.57005	0.70088	5.022
Piedmont	" 16	90.0	1.64660	0.00039	9.99979	1.64678	1.22353	0.57105	0.69932	5.004
Arcadia, *a*	" 17	87.2	1.65878	0.00040	0.00048	1.65966	1.22350	0.55814	0.68923	4.889
Pilot Knob, base	" 19	92.0	1.68684	0.00043	9.99965	1.68692	1.22355	0.53063	0.66178	4.590
" on top	" 20	77.7	1.68246	0.00043	0.00252	1.68541	1.22334	0.53223	0.66351	4.608
De Soto	" 21	89.0	1.66945	0.00036	9.99831	1.66812	1.22352	0.54970	0.68022	4.789
Pacific (oscill.)	" 27	93.0	1.67414	0.00044	0.00031	1.67489	1.22358	0.54299	0.67552	4.737
" (defl.)	" 27	94.5	....	....	....	....	....	....	....	4.707
Cuba	" 28	91.5	1.66126	0.00035	0.00083	1.66244	1.22356	0.55542	0.68902	4.887
Salem	" 29	93.0	1.65436	0.00045	9.99973	1.65454	1.22358	0.56334	0.69490	4.953
"	" 29	92.0	1.65446	0.00042	9.99991	1.65479	1.22356	0.56307	0.69476	4.952
Houston	Aug. 1	83.5	1.64636	0.00039	0.00146	1.64821	1.22344	0.56953	0.70160	5.030
Howell Co	" 3	72.7	1.65212	0.00031	0.00369	1.65612	1.22326	0.56144	0.69364	4.940
Beardstown, Ills.	" 9	87.0	1.69810	0.00033	0.00072	1.69915	1.22349	0.51864	0.65088	4.476
O'Fallon, Mo.	Oct. 31	61.0	1.67414	0.00047	0.00605	1.68066	1.22309	0.53673	0.66932	4.670

Intensity — Deflections.

Station.	Date.	t.	r ft.	Logarithms.			
				u'.	$1+\frac{h}{f}$	Corrected tan u.	$\frac{m}{H}$
Lutesville	July 6	90.0	2.00	1.64425	0.00103	8.57010	9.17377
"	" 6	88.2	1.75	1.81773	0.00106	8.74384	9.17400
Charleston	" 8	91.0	2.00	1.64357	0.00110	8.56948	9.17315
"	" 8	90.3	1.75	1.81707	0.00117	8.74330	9.17346
Poplar Bluffs	" 10	93.3	2.00	1.63799	0.00094	8.56371	9.16738
"	" 10	95.0	1.75	1.81174	0.00094	8.73772	9.16788
Piedmont	" 16	89.0	2.00	1.64231	0.00109	8.56807	9.17174
"	" 16	82.7	1.75	1.81690	0.00112	8.74292	9.17308
De Soto	" 21	80.3	2.00	1.66011	0.00094	8.58585	9.18952
"	" 21	81.5	1.75	1.83278	0.00098	8.75884	9.18900
Pacific	" 27	95.0	2.00	1.66474	0.00094	8.59053	9.19420
"	" 27	94.0	1.75	1.83891	0.00101	8.76502	9.19518
Cuba	" 28	94.8	2.00	1.64921	0.00096	8.57492	9.17860
"	" 28	96.2	1.75	1.82004	0.00091	8.74602	9.17618
Salem	" 29	92.2	2.00	1.64431	0.00092	8.57005	9.17372
"	" 29	91.3	1.75	1.81719	0.00095	8.74320	9.17336
Beardstown, Ills.	Aug. 9	90.5	2.00	1.68741	0.00095	8.61322	9.21689
" "	" 9	90.5	1.75	1.86052	0.00102	8.78671	9.21687

INCLINATION, OR DIP.

Needle No. 2.

STATION.	Marked End.		Means by Polarities.		Resulti'g Dip.	Date.
	North.	South.	Series I.	Series II.		
Lutesville..........	67°36'.4	67°57'.1	67°39'.3	67°54'.2	57°46 .7	July 6
Charleston..........	67 38 .9	67 56 .7	67 37 .4	67 58 .2	67 47 .8	" 8
Poplar Bluffs........	66 59 .7	67 20 .8	67 10 .2	66 21 .7	67 10 .2	" 10
Piedmont...........	67 14 .3	67 51 .0	67 17 .4	67 47 .9	67 32 .6	" 16
Arcadia.............	68 28 .9	68 38 .6	68 22 .3	68 43 2.	68 32 .7	" 17
Pilot Knob, *b*	69 50 .0	70 02 .8	69 48 .7	70 04 .1	69 56 .4	" 19
De Soto	68 38 .2	68 48 .9	68 34 .3	68 52 .8	68 43 .5	" 21
Pacific..............	68 53 .5	68 05 .6	68 52 .4	69 06 .7	68 59 .5	" 27
Cuba	68 05 .4	68 27 .2	68 04 .4	68 28 .2	68 16 .3	" 28
Salem	67 46 .8	68 10 .8	67 50 .4	68 07 .2	67 58 .8	" 29
Houston	67 04 .4	67 27 .0	67 03 .8	67 27 .6	67 15 .7	Aug. 1
Howell Co.	67 24 .5	67 43 .9	67 18 .2	67 50 .1	67 34 .2	" 3
Beardstown, Ills. ...	70 07 .8	70 13 .7	70 05 .5	70 15 .8	70 10 .7	" 9

Needle No. 3.

STATION.	Marked End.		Means by Polarities.		Resulti'g Dip.	Date.
	North.	South.	Series I.	Series II.		
Lutesville..........	68°19'.5	67°34'.0	67°57'.8	67°55 .7	67°56'.7	July 6
Charleston..........	68 07 .0	67 25 .1	67°44 .5	67 47 .6	67 46 .1	" 8
Poplar Bluffs	67 34 .6	67 01 .0	67 23 .8	67 11 7	67 17 .8	" 10
Arcadia............	68 47 .2	68 23 .1	68 33 .9	68 36 .3	68 35 .1	" 17
De Soto............	68 58 .7	68 35 .9	68 41 .9	68 52 .7	68 47 .3	" 21
Cuba	68 34 .6	68 08 .3	68 21 .6	68 21 .3	68 21 .4	" 28
Salem	68 20 .1	67 49 .3	68 04 .8	68 04 .5	68 04 .7	" 29
Houston	67 35 .0	66 59 .0	67 17 .3	67 16 .7	67 17 .0	Aug. 1
Howell Co.	67 57 .1	67 22 .9	67 41 .6	67 38 .4	67 40 .0	" 3
Beardstown, Ills. ...	70 42 .4	70 26 .4	70 26 .2	70 26 .7	70 26 .4	" 9

In conclusion, it may be stated that the observations of the past summer have, so far as they go, confirmed in a most striking manner the suggestions in the former report regarding the cause of abnormal deviations of the magnetic needle. The question is not yet regarded as settled, and a more detailed examination of the region between the lower Missouri and the Meramec rivers, and the region between the Osage and Missouri valleys, as well as that between the Missouri and the Grand rivers, is absolutely necessary in order to decide the points at issue. This has now been made possible through the unsolicited offer of a gentleman of St. Louis, who will pay the entire field expense of the work.

During 1880 the following gentlemen aided in paying the expenses of the survey: John T. Davis, Joseph Franklin, Edwin Harrison, Henry Hitchcock, W. A. Hargadine, Geo. E. Leighton, Geo. Partridge, W. H. Pulsifer. J. R. Shepley, E. C. Simmons, Charles Speck, Albert Todd, Thos. E. Tutt, James E. Yeatman, of St. Louis, and W. W. Baldwin of Burlington, Iowa, and W. H. Lynch of Salem, Mo.

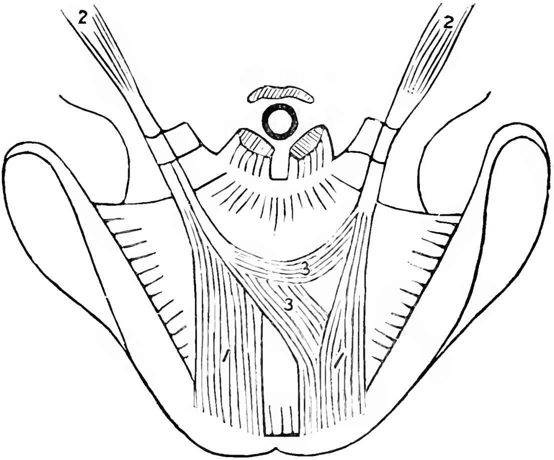
The following railroads have granted free passes: St. Louis, Iron Mountain and Southern; St. Louis and San Francisco; St. Louis, Salem and Little Rock; Wabash and Pacific; St. Louis, Keokuk and Northwestern; Chicago, Burlington and Quincy; Cairo and St. Louis.

My thanks are due to all these and also to E. K. Woodward, Jr., a student of Washington University, who rendered faithful and efficient service in the field work, and to Mr. B. D. Kribben of St. Louis, who assumed charge of the weather service in my absence.

"*Reversion of Type*" *in the Digastric Muscle of the Human Being.*

By CHARLES A. TODD, M.D.

No. 1.

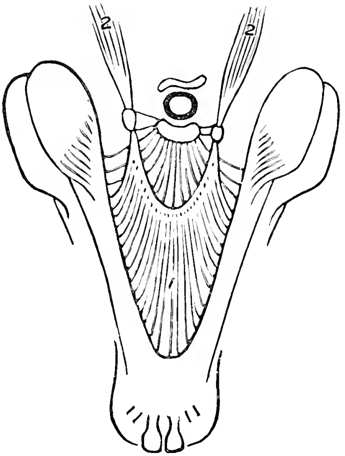


HUMAN LOWER JAW, UNDER SURFACE.

1. Anterior bellies, *musc. digastricus*. 2. Posterior bellies, *musc. digastricus*.
3. Abnormal arrangement of fibres of the anterior bellies.

While engaged, several years back, in dissecting the head of a boy aged about seven years, I found a condition of one of the large muscles attached to the lower jaw that I had never before observed, nor could I find any reference to such a condition in any works on human anatomy within my reach. The anomaly was this: The very important depressor muscle of the lower jaw, the digastricus on the right side, divided its anterior belly into two portions, one part being attached to the jaw as usual, the other passing across the median line to join its fellow upon the left. In the diagram, it will be observed that a bundle of these errant fibres make an arch with the left anterior belly, while the rest pass onwards in the same general direction with

No. 2.



MONKEY'S LOWER JAW (NAT. SIZE), UNDER SURFACE.

1. Anterior mass of *musc. digastricus*. 2. Posterior bellies of *musc. digastricus*.

the belly. In the diagram, the triangular space between these differently running fibres is represented as open; in fact, there was no such free space, the fibres being close together and held in position by connective tissue. An accurate drawing of the appearances was made from the dissected specimen.

Since making this dicovery I have noted that in all the monkeys examined dying at the St. Louis Zoölogical Garden, the two anterior bellies of the digastricus (which otherwise resembles the normal human) form one continuous sheet of muscle, as shown in the diagram. In these animals, however, there is a tendinous arch continuous with the tendons of the two digastrics and crossing in front of the hyoid bone; from this arch the fibres of the anterior muscular mass take origin.

The resemblance between this normal form of the digastricus in the monkey and the human abnormity recorded is most striking, and will be regarded by some Biologists as a good illustration of "reversion of type."

Ephemeris of the Satellites of Mars for the Opposition of 1881.

By H. S. Pritchett.

Owing to the greater distance from the Earth and the Sun the present opposition of Mars will not be so favorable as the two preceding ones; still these distances will be sufficiently small to permit many useful observations of physical phenomena, and, in the case of large telescopes, observations of the satellites. In one respect the planet is much more favorably situated than in the former oppositions referred to, since it reaches this year a declination of 26° north and hence will be observed at a much higher altitude. Physical observations, either measures or drawings, by amateur astronomers with good glasses, if carefully made and published, will be useful when finally reduced and compared.

During the last opposition several series of micrometric measures of the diameter of the planet were made by observers with good telescopes which showed curious differences both between themselves and when compared with the results obtained from the heliometer. Some of these measures seemed to show an appreciable flattening at the poles, while others showed no such flattening. It will be interesting to have these measures repeated during the present opposition, with a careful discussion of the sources and effects of personal error.

The satellites were observed last opposition with at least one of the large reflectors, with the great refractor at Washington, with the 15-inch refractor of the Harvard College Observatory, and with the 12¼-inch refractor of the Morrison Observatory, and were seen with other instruments. Before December 1st of this year the satellites will be considerably brighter than when last observed in 1879 with the Harvard College refractor, and also brighter than when last observed with the Morrison Observatory refractor. It seems possible, therefore, that they may be seen this year with telescopes even of moderate size.

The following ephemeris (derived from the elements of Prof. A. Hall, A. N. No. 2394) has been computed at the request of several observers, and will be found convenient for any who may wish to observe these satellites. In connection with the discussion of the relative merits of reflectors and refractors, excited by the observations of these satellites, it may be interesting to many to try if they can see them.

In the case of Deimos, the outer satellite, the ephemeris gives the Washington mean times of the east and west elongations together with the position-angle and distance at the time of elongation. In the case of Phobos only the times of western elongations are given as the revolution time is very short and the times of eastern elongations may be obtained by a simple interpolation. The aberration time is not included in the time given, but it may be taken from the table at the end if desired, the effect of the aberration being to make the satellites about five minutes late at each elongation. The relative brightness on different days may be obtained from the same table, taking the brightness on Nov. 20 as unity. As was shown by the observations of 1879, Prof. Hall's elements are very nearly correct, so that the correction to this ephemeris will be quite small.

DEIMOS.

Date.	Direction of Elongation.	Wash. M. T.		Pos. Ang.	Dist.	Date.	Direction of Elongation.	Wash. M. T.		Pos. Ang.	Dist.
		h.	*m.*					*h.*	*m.*		
Nov. 19	W	21	59	252°.4	46''.7	Dec. 5	E	16	33	....	......
20	E	13	8	....	......	6	W	7	42	....	......
21	W	4	17	....	......		E	22	50	....	......
	E	19	26	....	......	7	W	13	58	....	......
22	W	10	34	....	......	8	E	5	7	....	......
23	E	1	43	....	......		W	20	14	250°.2	52''.4
	W	16	52	....	......	9	E	11	23	....	......
24	E	8	1	....	......	10	W	2	31	....	......
	W	23	10	....	......		E	17	39	....	......
25	E	14	19	....	......	11	W	8	47	....	......
26	W	5	27	252°.1	48''.7		E	23	55	....	......
	E	20	36	....	......	12	W	15	3	....	......
27	W	11	44	....	......	13	E	6	11	....	......
28	E	2	53	....	......		W	21	19	249°.7	53''.2
	W	18	1	....	......	14	E	12	27	....	......
29	E	9	10	....	......	15	W	3	35	....	......
30	W	0	18	....	......		E	18	43	....	......
	E	15	27	....	......	16	W	9	51	....	......
Dec. 1	W	6	35	....	......	17	E	0	59	....	......
	E	21	44	....	......		W	16	7	....	......
2	W	12	52	251°.5	50''.8	18	E	7	15	....	......
3	E	4	1	....	......		W	22	23	....	......
	W	19	9	....	......	19	E	13	31	....	......
4	E	10	17	....	......	20	W	4	39	248°.5	53''.7
5	W	1	25	....	......		E	19	47	....	.....

DEIMOS—Continued.

Date.	Direction of Elongation.	Wash. M. T. h.	m.	Pos. Ang.	Dist.	Date.	Direction of Elongation.	Wash. M. T. h.	m.	Pos. Aug.	Dist.
Dec. 21	W	10	54	....	......	Dec. 30	W	6	44	....	......
22	E	2	2	....	......		E	21	52	....	......
	W	17	10	....	......	31	W	13	0	....	......
23	E	8	19	....	......	Jan. 1	E	4	7	....	......
	W	23	26	....	......		W	19	15	245°.9	52″.4
24	E	14	33	....	......	2	E	10	23	....	......
25	W	5	41	....	......	3	W	1	31	....	......
	E	20	49	....	......		E	16	39	....	......
26	W	11	57	....	......	4	W	7	47	....	......
27	E	3	5	....	......		E	22	55	....	......
	W	18	12	....	......	5	W	14	3	....	......
28	E	9	20	....	......	6	E	5	11	....	......
29	W	0	28	....	......		W	20	19	....	......
	E	15	36	....	......						

PHOBOS.

Date.		Wash. M.T. h.	m.	Pos. Ang.	Dist.	Date.		Wash. M.T. h.	m.	Pos. Ang.	Dist.
Nov.	19	22	51	252°.3	18″.7	Nov.	29	4	48	....	......
	20	6	30	....	......			12	27	....	......
		14	10	....	......			20	6	....	......
		21	49	....	......		30	3	45	....	......
	21	5	28	....	......			11	24	....	......
		13	7	....	......			19	3	....	......
		20	47	....	......	Dec.	1	2	42	....	......
	22	4	26	....	......			10	22	....	......
		12	5	....	......			18	1	....	......
		19	44	....	......		2	1	40	251°.5	20″.3
	23	3	24	....	......			9	19	....	......
		11	3	....	......			16	58	....	......
		18	42	....	......		3	0	37	....	......
	24	2	22	....	......			8	16	....	......
		10	0	....	......			15	56	....	......
		17	40	....	......			23	35	....	......
	25	1	19	....	......		4	7	14	....	......
		8	58	....	......			14	53	....	......
		16	37	....	......			22	32	....	......
	26	0	16	252°.1	19″.5		5	6	12	....	......
		7	56	....	......			13	51	....	......
		15	35	....	......			21	31	....	......
		23	14	....	......		6	5	10	....	......
	27	6	53	....	......			12	49	....	......
		14	32	....	......			20	28	....	......
		22	11	....	......		7	4	7	....	......
	28	5	51	....	......			11	46	....	......
		13	30	....	......			19	25	250°.4	20″.9
		21	9	....	......						

PHOBOS—Continued.

Date.		Wash. M.T. h.	m.	Pos. Ang.	Dist.
Dec.	8	3	5	....	......
		10	44	....	......
		18	23	....	......
	9	2	2	....	......
		9	41	....	......
		17	20	....	......
	10	0	59	....	......
		8	39	....	......
		16	18	....	......
		23	57	....	......
	11	7	36	....	......
		15	15	....	......
		22	54	....	......
	12	6	33	....	......
		14	13	....	......
		21	52	....	......
	13	5	31	....	......
		13	10	....	......
		20	49	249°.7	21″.3
	14	3	28	....	......
		12	7	....	......
		19	46	....	......
	15	3	25	....	......
		11	4	....	......
		18	43	....	......
	16	2	23	....	......
		10	2	....	......
		17	41	....	......
	17	1	20	....	......
		8	59	....	......
		16	38	....	......
	18	0	17	....	......
		7	56	....	......
		15	35	....	......
		23	14	....	......
	19	6	53	....	......
		14	33	....	......
		22	12	....	......
	20	5	51	248°.5	21″.5
		13	30	....	......
		21	9	....	......
	21	4	48	....	......
		12	27	....	......
		20	6	....	......
	22	3	46	....	......
		11	25	....	......
		19	4	....	......
Dec.	23	2	43	....	......
		10	22	....	......
		18	1	....	......
	24	1	40	....	......
		9	19	....	......
		16	58	....	......
	25	0	37	....	......
		8	16	....	......
		15	55	....	......
		23	34	247°.3	21″.4
	26	7	13	....	......
		14	53	....	......
		22	32	....	......
	27	6	11	....	......
		13	50	....	......
		21	29	....	......
	28	5	8	....	......
		12	47	....	......
		20	26	....	......
	29	4	5	....	......
		11	44	....	......
		19	23	....	......
	30	3	3	....	......
		10	42	....	......
		18	21	....	......
	31	2	0	....	......
		9	39	....	......
		17	18	....	......
Jan.	1	0	57	246°.0	21″.1
		8	36	....	......
		16	15	....	......
		23	54	....	......
	2	7	33	....	......
		15	13	....	......
		22	52	....	......
	3	6	31	....	......
		14	10	....	......
		21	49	....	......
	4	5	28	....	......
		13	7	....	......
		20	46	....	......
	5	4	25	....	......
		12	4	....	......
		19	43	....	......
	6	3	23	....	......
		11	2	....	......
		18	41	....	......
	7	2	20	....	......

Date.	Brightness.	Semi-diam. Mars.	Aberration Time.
1881.			m.
Nov. 20.0	1.00	6".7	−5.7
26.0	1.07	7 .0	5.5
Dec. 2.0	1.15	7 .3	5.3
8.0	1.21	7 .5	5.2
14.0	1.24	7 .6	5.0
20.0	1.26	7 .7	5.0
26.0	1.24	7 .7	5.0
Jan. 1.0	1.18	7 .6	−5.1

From this it will be seen that Phobos, even on the most favorable date, will be only about 14" distant from the limb of the planet. In 1877 this satellite was observed with the 12¼ equatorial of the Morrison Observatory when only 7" distant. In the present opposition the satellite will be much fainter, but on the other hand the brightness of the planet will be considerably diminished. It seems possible, therefore, that this satellite may be seen with glasses of moderate size.

Washington University, Nov., 1881.

The Genus ISOËTES *in North America.*

By Dr. GEORGE ENGELMANN.

§ 1. *History of* ISOËTES *in North America.*

The *Isoëtes*, insignificant and apparently sterile as they are, were long overlooked or ignored by our botanists, so that until thirty or forty years ago very few specimens were collected, and none were distinguished from *I. lacustris*, if we except Nuttall's guess at his Oregon discovery; but the genus has attracted so much attention, and lately so many forms have become known, that it seems to me an interesting task to trace up the history of the discovery of the different species and their varieties, and of the area of their distribution, and then the date of their publication, before I enter into their scientific description.

I. DISCOVERY.

1806 (?). The first notice which we have of an *Isoëtes* in North America is given in Pursh's Flora, ii. 671, where he states that "*Isoëtes lacustris*" grows in the bottom of Oswego river, near the falls, and adds his *v. v.*, which means that he saw it living, and therefore probably found it himself; and as he travelled through the regions near the Great Lakes in 1806, it was probably in that year that he met with it. I have not seen Pursh's specimens, but doubt not but that it will have to be referred to *I. echinospora*, var. *Braunii*, the only form thus far known from Western New York.

1815. Th. Nuttall collected "*I. lacustris*," abundant along the inundated gravelly and miry shores of the Delaware at Gibsonville (now a part of Philadelphia) on Aug. 22d, according to the label of a specimen in Collins' Herbarium, presented to me by E. Durand. It proves to be *I. riparia*.

1820 (?). L. von Schweinitz obtained in the Catskill Mountains in New York *I. lacustris;* some of his specimens are now found in the Herb. Philad. Acad. Natural Science and one in the St. Petersburg Imperial Herb. Some of them are labeled "Catskill Mountains" and others "Bethlehem," the latter, which was von Schweinitz's residence, probably by mistake. One of the specimens was loaned by the late Elias Durand—in whose possession it was—to Durieu de Maissonneuve, who founded on it his I. MACROSPORA. No date being indicated on the labels, the above-mentioned year is a mere guess.

1825 (?). Jens Vahl collected in Greenland a small *Isoëtes*, referred to *I. lacustris*, which proves to be one of the forms of *I. echinospora*.

1831. J. W. Robbins gathered an *Isoëtes* near Uxbridge, Mass., which I recognize as *I. riparia*.

1832. C. J. Moser, who collected for the German *Unio itineraria*, obtained specimens on the Lehigh river near Bethlehem, Pa., and near Philadelphia, both of which were distributed to the subscribers as *I. lacustris*. One of these (in Herb. Bernhardi, now in the Herb. Missouri Bot. Garden) represents *I. Engelmanni;* another, which I have seen in Europe, is *I. riparia*.

1834. Th. Nuttall discovered an *Isoëtes* on the Columbia river in Oregon, which I saw in E. Durand's Herb. with Nuttall's own label, *I. opaca ;* it was afterwards named I. NUTTALLII.

About the same year Drummond collected "*I. lacustris*" on the Saskatchawan, according to Hooker's Fl. Bor. Am. ii. 268, which I have not been able to compare and to identify.

1840. J. W. Robbins found *I. lacustris* near Uxbridge.

1842. Rugel discovered an *Isoëtes* in Lake Imonia in Florida, which was soon afterwards distributed in Europe by Shuttleworth under the name of I. FLACCIDA. None of his specimens are believed to exist in America.

In the same year N. Riehl and myself found near St. Louis, Missouri, the species which from my specimens was by A. Braun named I. ENGELMANNI.

1843. Chas. Geyer found in Western Idaho *I. Nuttallii*, according to A. Braun, who examined the specimens in the Kew Herbarium.

In the same year S. Tuckerman collected *I. lacustris* in the Echo lake in New Hampshire.

1844. Wm. Zantzinger rediscovered the *Isoëtes* on the banks of the Delaware near Philadelphia. His specimens, sent to me, are the type of my I. RIPARIA.

1845. T. W. Robbins found in Massachusetts *I. echinospora*, var. *Braunii*.

1848. E. Tuckermann discovered near Boston the species which was by A. Braun named for him I. TUCKERMANI.

1850. A. W. Chapman found in Northern Florida a peculiar *Isoëtes*, which proved to be a large-spore form of *I. flaccida*, and was named var. CHAPMANI.

1853. E. Hall discovered in his fields near Athens in Central Illinois the species which was afterwards named by J. Gay I. MELANOPODA.

1856. I found *I. echinospora*, var. *Braunii*, in Lake Winnipiseogee in New Hampshire, the type of I. BRAUNII, Durieu.

1857. E. D. Eaton obtained *I. Engelmanni* for the first time in the New England States.

1860. Wm. Boott found near Boston the form of *I. echinospora*, which was named from his specimens I. MURICATA by Prof. Durieu, the present *I. echinospora* var. *muricata*.

1862. Th. C. Porter discovered near Lancaster, Pa., the largest American *Isoëtes*, *I. Engelmanni*, var. VALIDA.

In the same year G. Vasey found *I. melanopoda* in Iowa.

1863. I. Macoun obtained *I. echinospora*, var. *Braunii*, in West Canada.

In the same year Wm. M. Canby discovered in Maryland I. SACCHARATA.

1865. Leidy and Porter collected *I. lacustris* near the outlet of Lake Superior.

In the same year *I. Tuckermani* was rediscovered near Boston by Wm. Boott.

1866. Chs. Wright discovered I. CUBANA in Eastern Cuba.

In the same year H. Bolander found two new species in the Sierra Nevada of California, I. BOLANDERI and I. PYGMÆA.

1867. Wm. Boott got near Boston the species named after him I. BOOTTII. now known as *I. echinospora*, var. *Boottii*.

1869. Wm. M. Canby discovered on the Stone Mountain in Georgia the curious little I. MELANOSPORA.

In the same year S. Watson found *I. echinospora*, var. *Braunii*, in Utah.

1871. E. Hall gathered beautiful specimens of *I. Nuttallii* on the Columbia river.

1872. The same traced *I. melanopoda* to Texas.

1873. T. P. James got *I. echinospora*, var. *Braunii*, in Nova Scotia and C. C. Parry found *I. Bolanderi* in Yellowstone lake in Wyoming.

1875. G. D. Butler discovered in the Indian Territory the species named for him I. BUTLERI, and with it a new locality for *I. melanopoda*.

1878. C. G. Pringle found in Lake Champlain the form of *I. echinospora*, which I have designated as var. ROBUSTA.

1879. M. E. Jones met with *I. Bolanderi* in Utah.

1880. A. Gattinger discovered near Nashville, Tennessee, a *I. Butleri*, var. IMMACULATA.

1881. I collected *I. lacustris* var. PAUPERCULA in Grand Lake, Middle Park, Colorado, and C. G. Pringle found the same in Northern California.

2. PUBLICATION.

1753. Linnæus published in his *Species Plantarum*, ed. i., his *Isoëtes lacustris*, the only species known to him.

Neither Michaux nor any of the older writers on American plants knew of any North American *Isoëtes*.

1816. Pursh, Fl. Am. Sept. ii. 671, mentions "*I. lacustris*" from Oswego river, Western New York, which is most probably *I. echinospora*, var. *Braunii*, the only species thus far known from that region.

1818. Nuttall, Gen. ii. 253, has "*I. lacustris*" from the miry shores of the Delaware near Philadelphia, which cannot be any other than *I. riparia*; he also gives Pursh's habitat.

In the same year Barton, Fl. Philad. ii. 213, has "*I. lacustris*" from Philadelphia, which may include both *I. riparia* and *I. Engelmanni*.

1824. Elliott knows no *Isoëtes*.

1826. Torrey (Comp. Fl. North. & Middle States) gives as habitat of "615, *I. lacustris*," bottoms of lakes, evidently without having himself seen it.

In the Flora Cestrica of the same year Darlington does not mention the genus.

1827. Sprengel, Syst. Plant. iv. 9, knows only *I. lacustris* with three varieties.

1833. Beck in his Botany repeats Pursh's and Nuttall's localities.

1840. Hooker, Fl. Bor. Am. ii. 268, mentions "*I. lacustris*" from the Saskatchawan. This may be the true *lacustris* or a form of *echinospora*, either of which may be expected in those regions.

1843. Torrey, Flora of New York, ii. 514, "*I. lacustris*," a mere repetition of Pursh's statement.

1844. Bory investigates the Genus, which until then had been very much neglected, and adds to the three then known species (*I. lacustris, Coromandelina*, and *setacea*) three new ones discovered in Algeria by Durieu de Maissonneuve.

1846. A. Braun, in Regensburg bot. Zeitung, No. 12, briefly characterizes *I. riparia*, Engelm., from Philadelphia; *I. Engelmanni*, A. Br., from Missouri, and *I. flaccida*, Shuttlew., from Florida.

1847. The Amer. Journ. Arts & Sciences, n. ser. iii. 52, publishes a translation of the above notice.

1848. A. Gray, in the first edition of the Manual Bot. North. States, p. 640, distinguishes the then known three northern species, *I. lacustris*, *I. riparia*, and *I. Engelmanni*.

1853. Darlington, Fl. Cest. ed. ii. p. 402, mentions "*I. lacustris*" as growing in shallow ponds in his district. This must refer to *I. Engelmanni*, the only species growing there in such localities.

1856. A. Gray, Manual, ed. ii., gives an almost verbal reprint of the first edition.

1860. Chapman, Fl. South. States, p. 602, describes *I. flaccida* as growing in "lakes and clear streams" in Middle and West Florida.

In the same year E. Tatnall, Cat. Pl. Newcastle Co., Delaware, enumerates *I. riparia* and *I. Engelmanni*, both of which names here probably stand for the latter.

1861. Durieu de Maisonneuve, Prof. of Botany at Bordeaux, in Bull. Soc. Bot. France, viii. p. 164, distinguishes and characterizes the two North European species *I. lacustris* and *I. echinospora*, heretofore thrown together.

1864. The same author, l. c. 101, 102, indicates four American *Isoëtes: muricata* from Massachusetts, *Braunii* from New Hampshire, *macrospora* from the Catskill Mountains, and *melanopoda* Gay (or Gay and Durieu) from Illinois.

In the same year A. Braun published a most important treatise on the Genus in his account of the *Isoëtes* of the Island of Sardinia, in which our species are frequently referred to.

1867. In the fifth edition of Gray's Manual, p. 676, I for the first time published *I. echinospora* as an American species, differing in several varieties from the European type—var. *Braunii* (*I. Braunii*, Dur.), var. *muricata* (*I. muricata*, Dur.), and var. *Bootti* (*I. Boottii*, A. Braun in lit.), all of them from the North-eastern States; also *I. Tuckermanni*, A. Braun in lit., from Massachusetts, and *I. saccharata*, Engelm., from Maryland.

1874. In Dr. Parry's Botanical Observations in Western Wyoming, Am. Naturalist, viii. 214, 215, I gave an account of the three western species: *I. Bolanderi*, Engelm.; *I. pygmæa*, Engelm., and *I. Nuttallii*, A. Br. in lit.

1877. My notice of *I. melanospora*, Engelm., from Georgia was published in the Trans. Acad. Sci. St. Louis, iii. 395, note.

1878. In Coulter's Botan. Gazette for January, p. 1, I gave an account of *I. Butleri*, Engelm., found in the Indian Territory west of Arkansas.

§ 2. *Morphology of Isoëtes.*

The species of *Isoetes* are the simplest vascular plants known. They consist of a short trunk* with root-fibres at its base and leaves on its top, normally withoul branching and without any axillary productions.†

The TRUNK is generally depressed, broader than high, or flatter in some species (*I. Engelmanni*), and thicker and more globose in others (*I. melanopoda*), but its form is not constant; it is concave on the upper side and even somewhat funnel-shaped where the leaves are inserted, while the underside shows in almost all the N. American species two grooves and in many exotic ones three grooves, dividing the trunk more or less deeply into two or into three lobes. The number of lobes rarely varies, so that among the many hundreds and even thousands of American specimens which have passed through my hands, I have found only a single, normally bilobed, one with three lobes; this was an *I. riparia* from Philadelphia. In the 3-lobed species

* A very complete account of the structure of the trunk is given by H. Mohl in Linnæa xiv. (1840) 181, and of the whole plant and its morphology by A. Braun in the *Isoëtes* der Insel Sardinien. Monatsber. d. Berliner Acad. Wissensch. 1864.

† Abnormally the *Isoëtes* trunk has been seen divided, probably in consequence of some injury; I myself have seen a specimen of *I. Tuckermani* with four distinct bunches of leaves from a single trunk. K. Goebel fund a proliferous *Isoëtes* with lateral shoots in place of spore cases. Bot. Zeitung, 1879, No. 1.

the transverse section is rather circular, but in the 2-lobed ones it is usually oblong or often somewhat rectangular, narrower in the direction of the grooves and wider in the opposite direction; the vertical section of the trunk shows a thickness of from 1 to 6 lines, and the transverse diameter a width of a few lines to more than one inch. In the centre of the trunk we find a small ligneous body, fibres from which enter the leaves and the roots. The mass of the trunk is a white parenchymatous or rather cortical tissue, the cells of which are filled with starch. The growth proceeds from the central ligneous body outwardly in two or three directions, corresponding to the two or three lobes, so that these lobes would spread laterally if their enlargement were not limited by the decay of the older (the preceding year's?) parts. We thus find that at the period of the most vigorous growth, about the beginning of fructification, the extreme lateral portion of the lobes becomes discolored, brownish, atrophied, and at last black, and is separated from the living tissues by a distinct line of demarcation, and at last generally falls off at the end of this or the beginning of the next season as a black mould-like mass. In some species, e.g. *I. lacustris*, and in colder climates the atrophied cortical parts continue to cohere for several seasons, and in the Mediterranean *I. Hystrix* they do not seem ever to be detached, so that the trunk of this species reaches a larger size than any other.

The decaying portions are pushed obliquely upwards when the base of the trunk grows faster than the upper part (often in *I. Engelmanni*, and much more so in the Australian *I. tripus*), or horizontally outward (the ordinary case), or downward when the upper or leaf-bearing part expands more than the lower, root-bearing part. This last is the case in *I. Hystrix*, where the dead parts are turned downwards.

As the growth of the trunk takes place from the centre outward, the roots, originating from the youngest parts, start from the groove itself; and fresh and living, whitish, ones are only found in or near this groove: as they get older they are pushed to the sides, and finally die, becoming brown and black. The mass of roots found on *Isoëtes* specimens are mostly the entangled dead fibres, which, by the way, often conceal spores of the previous year, and therefore must be carefully examined when no fresh spores are attainable. The root-fibres, sometimes longer than the leaves, are always dichotomously, and often many times, branched. — The upper, concave, surface of the trunk bears the leaves, the innermost or youngest ones often yet immersed in the trunk.

The LEAVES are subulate or sometimes almost filiform tubular organs from a broad membranaceous sheathing base, mostly more or less quadrangular (broader and with sharper edges on the upper or ventral, narrower on the dorsal side), or in our terrestrial species more triangular and keeled on the back. Their sheathing bases form the *bulb*, which can be compared to the bulb of liliaceous plants; in fertile specimens it is always larger and thicker than the trunk, and in some of the larger ones, e.g. *I. Engelmanni* and *I. melanopoda*, attains a diameter of one or two inches. The leaves above this base contain four longitudinal air cavities, *lacunæ*, separated from one another by two dissepiments, a transverse and a median one, and irregularly divided by very thin transverse *septa*. The dissepiments are of different, pretty constant, thickness in the different species, thinnest in the amphibious and thickest in the terrestrial species, consisting in the former often of only 2 to 4, in the latter of 6 to 9 layers of parenchymatous cells; the median dissepiment is generally a little thicker than the transverse one. The anterior *lacunæ* are mostly somewhat larger than the posterior ones.

The epidermis of the leaf consists of rectangular cells, mostly much longer than they are wide; only in *I. pygmæa* are they comparatively short, and sometimes even square. In a few species the epidermis is entirely destitute of stomata, in the others it is pierced by stomata which communicate with the air-ducts, over which alone they are found. The presence or absence of stomata furnishes a very important character for the diagnosis and classification of the species. It was formerly thought that the submerged species had no stomata, and those species which bear their leaves more or less exposed to the air were provided with them; later discoveries, however, have shown that this rule does not always hold good, for we now know submerged species with stomata and emerged ones without them, and we have one submerged species (*I. echinospora*) in which the typical European form is destitute of stomata, while the American varieties show either a few stomata, often difficult to discover, or, rarely, numerous ones; so that in this interesting species the question arises whether the presence or absence of stomata *alone* can specifically separate forms otherwise scarcely distinguishable, as that acute observer of these plants, A. Braun, has maintained, or whether the stomata do *not* always play that important part in classification generally assigned to them. Below will be found directions for the investigation of the stomata.

The parenchyma of the leaf consists of a few or several layers of chlorophyll-bearing cells, 1. under the epidermis, 2. around the central bundle of vessels, and 3. forming the dissepiments, which cross each other in the centre of the leaf.

An important element in the leaf structure is found in the peripheral bast-bundles, which are present in some and absent in other species; and their presence often, but not always, coincides with the presence of stomata. When present they commonly form four bundles, two in the two anterior angles of the leaf, and two where the median dissepiments connect with the anterior and the posterior wall of the leaf; in *I. Nuttallii* I find only three bundles, the anterior median one being wanting; in *I. Cubana* six bundles are visible, the two additional ones being located where the transverse dissepiment unites with the outer wall. In some rigid-leaved land species, e.g. *I. melanopoda*, often several smaller accessory bundles are found scattered under the epidermis.

The examination of the fresh *Isoëtes* leaf is not very difficult; particles of the epidermis are easily removed and show the stomata, when present, very distinctly. Where there are few stomata, the epidermis from different parts of the leaf must be examined, and especially from the tip, as they are more apt to be found there. In dried specimens the leaf must be soaked, the *algæ* which often adhere to the surface have to be carefully scraped off, after which I make several sections $\frac{1}{4}$ or $\frac{1}{2}$ line wide, lay them open by a vertical slit, detach the central bundle, and then scrape very gently the inner surface so as to remove the parenchymatous cells which obscure the appearance of the stomata This process can be aided by an immersion of the specimen in a weak solution of caustic potash. The work is often a difficult one when the specimen is very old or poorly preserved, and requires a good deal of patience. Sometimes the application of iodine will very distinctly show the stomata by coloring their guard-cells blue when only these contain amylon, but of course not when the other cells are also filled with that substance. A magnifying power of 150 to 250 diameters is best adapted to well exhibit the stomata.

To find the bast-cells it is necessary to make the thinnest possible transverse sections of the leaf, boil them well, and, if they do not then show under water as bundles of minute, thick-walled, darkish cells close to the epidermis, very distinct from the much larger epidermis cells, the application of a solution of caustic potash, to clear the preparation, will readily bring them out. The same magnifying power which we use for the examination of the stomata may be applied for the study of the bast-bundles.

I would advise anyone who desires to study the structure of *Isoëtes* leaves to commence with well known species and good (if possible fresh) specimens, and make himself familiar with the manipulation and with the appearance of their parts under the microscope before he proceeds to study unknown and difficult specimens.

The arrangement of the leaves in the species with two-lobed trunks is at first distichous, and in *I. melanospora* it remains so through life; in all the others the leaves soon enter into a more complicated phyllotactic order; in the larger ones, with many leaves the $\frac{13}{21}$ and even the $\frac{21}{34}$ order is found.

The number of leaves varies from 5 or 10 (*I. pygmæa*, *I. melanospora*) to 100 or even 200 (*I. Engelmanni*, var. *valida*), and their length from ½ to 1 inch (in *I. pygmæa*) to 1–2 feet (in some forms of *I. flaccida* and *I. Engelmanni*); their color from light and fresh yellowish-green (*I. Engelmanni*) to dark and dull green *I. lacustris*); their rigidity is greatest in the terrestrial species, and also in some submerged ones; and least in most amphibious species, which often float their leaves on the surface of the receding water, or in some submerged ones, the leaves of which, taken out of the water, collapse like the soft hair of a wet pencil. The submerged species vegetate and retain their verdure throughout the winter (whence, it is said, the name of the genus is derived: *Isoëtes*, equal at all seasons), but the others lose their leaves soon after their maturity in autumn, some of our terrestrial ones even already in summer.

The broad membranaceous sheathing base of the leaf is without air cavities, stomata, or bast-bundles; in sterile leaves it gradually contracts into the leaf itself. Those leaves are usually sterile which develope at the beginning and the end of the season. The fertile leaves have in their base an excavation which bears the spore-case, *sporangium*, adnate with its back to the midrib. Above this excavation, and separated from it by a deep transverse depression or slit, we find a stipule-like organ of triangular more or less elongated shape, cordate at base, appressed to the leaf, which is termed the *ligula;* it is small, and in not very fresh leaves often mutilated and difficult to make out. The morphology of these parts is obscure and their diagnostic value not great.

The sporangium is oblong or circular (both forms often seen in the same species), from ½ to 1 line long in *I. melanopoda*; 1 to 2 lines in *I. pygmæa*, *Tuckermani*, *echinospora*, and *saccharata;* 1½ to 2½ lines in *I. lacustris*, *Bolanderi* and *flaccida;* often a little larger in *I. Butleri* and *Nuttallii;* 2 to 4 lines in *I. riparia*, *Engelmanni*, *melanopoda*, and *Cubana;* and in larger forms of *I. Engelmanni* I have seen it 8 to 9 lines long. It is somewhat flattened, and often slightly concave on the ventral side; it is entirely naked or (the usual case) it is on its sides and principally upwards partially covered by a fold of the ventral side of the leaf-base, the veil (*velum*); in a few species (*I. flaccida*, *melanopoda*, and *Nuttallii*) this fold extends over the whole sporangium, completely covering it (*velum completum*). The sac of the sporangium is composed of two layers of cells; the outer, epidermidal, layer consists of elongated, often variously bent or hooked and curiously interlaced cells, mostly thin-walled and transparent; in some species (e.g. *I. riparia*, *I. saccharata*, *I. melanopoda*) groups of brown, thick-walled, (so-called) sclerenchym-cells are mixed with the transparent ones, giving the spore-case a dotted appearance visible even to the naked eye. The spore-case is traversed by numerous parallel strings.

Some sporangia, called *macrosporangia*, contain larger or female spores (*macrospores* or *gynospores*), others are filled with the minute or male spores (*microspores* or *androspores*); these are called *microsporangia*. Almost all the species are monœcious, bearing macrosporangia on the base of the outer and microsporangia on that of the inner leaves. I am not aware that any exotic species behave differently, but here we have two species which deviate from this norm. *I. melanopoda* in Illinois as well as in the Indian Territory, from both of which localities I have examined several hundreds of specimens, is polygamous, i.e. monœcious as well as diœcious, and shows about an equal number of male, female, and monœcious plants. The allied *I. Butleri* is apparently always diœcious, no monœcious plants having been discovered among about one hundred examined. In *I. melanopoda* I have sometimes seen leaves with microsporangia irregularly interspersed among those that bear macrosporangia.

The macrospores are little spheroid bodies between one-fourth and three-fourths of a millimeter in diameter. Their surface is divided by a circular rim in a lower hemispherical and an upper three-sided pyramidal part, the three faces of which consist of spherical triangles and are separated from one another by three elevated ridges. The crusty surface of these spores, chalky-white or whitish in most species and dusky (when wet black) in *I. melanospora*, is rarely smooth, but generally sculptured and differently marked. The three upper triangles are sometimes marked differently from the lower hemisphere (especially in *I. Tuckermani*) or are smoother than that (often in *I. melanopoda*). To examine the spores well it is necessary to soak the leaf-base, carefully remove some of the wet spores and let them dry on the slide, for they must be examined dry, and best under a power of 50 or 60 diameters; but, to study the sculpture well, a power of 100 to 150 diameters is necessary. With the aid of this we find the macrospores—1. Minutely tuberculated or warty; the warts small and mostly somewhat depressed, distinct or sometimes somewhat confluent, in *I. pygmæa*, *Bolanderi*, *saccharata*, *melanospora*, *Butleri*, and *Nuttallii*.

2. With larger, broader tubercles, generally more distant and distinct, but also here and there confluent, worm-like; thus in *I. flaccida*, *melanopoda*, and *Cubana*.

3. With tubercles elongated into spines; these are simple and very fragile, or here and there confluent and forming sometimes short crests: *I. echinospora* and its forms.

4. With crests and ridges, distinct or anastomizing: *I. lacustris*, *Tuckermani*, and *riparia*.

5. The confluent crests form a regular net-work: *I. Engelmanni*.

The microspores are minute bodies of an ash-gray or a dusky color (dark gray in *I. pygmæa*, *Bolanderi* and *melanopoda*, deep brown in *I. melanospora*, *Butleri* and *Nuttallii*) and of a somewhat triangular-oblong shape, nearly straight on one and curved on the two other edges, more than half as wide as they are long, between 0.020 and 0.040 millimeters in the longest diameter. Their surface is smooth or minutely papillose or spinulose, the edges smooth or somewhat cristate. Their size furnishes good characters, but the condition of the surface much less so. They ought to be examined under water and with a power of about 400 diameters.

§ 3. *Biological Characters.*

After the maturity of the spores the leaves wither or rot away, the sporangia decay and set the spores free, which scatter near the base of the plant, often being retained between the matted roots.* The cellular mass of the macrospores developes into a *prothallus*, which bursts the spore-case through the opening of three valves which correspond to the three upper faces of the spore, and forms an archegonium, which is fertilized on coming in contact with the zoöspores emitted from the microspores, and thus gives rise to the young plantlet whenever moisture and temperature favor this process.

The germination of the late-maturing water-species probably takes place in the succeeding spring, at least in the more northern localities; in our land- and marsh-species it may be observed soon after their maturity in summer or in early autumn.

I have studied the whole process in *I. Engelmanni*, which I kept in cultivation for several years. At the end of July the spores were perfectly mature and the leaves were coming off. On the 28th of that month I spread out both kinds of spores on a muddy surface and kept them slightly covered with water, and

* It is therefore proper to examine among the roots for spores whenever none can be found on the plant; one or the other may be discovered there and help out the diagnosis which otherwise may rest in obscurity.

fully exposed to the hot sunshine of that season. Three weeks later the first green points were seen and continued to come up until the end of October, while at that time the earlier ones had already developed 5 to 8 leaves, ½ to 1½ inches in length. The contents of the large or female spore-cell first developed into a dense cellular mass; this, enlarging, split the cell-coats as above described and protruded obliquely upwards a minute conical point, green inside, while on the lower edge of the opening, but still between the three valves (the lower hemisphere of the spore-case not being ruptured or perforated at all), a much smaller and rounded knob, the origin of the first rootlet, showed itself, bearing a large number of extremely fine capillary fibres; the bulk of the prothallus remained enclosed in the hemispherical part of the spore-case as a lateral knob, while the first leaf and then the first rootlet elongated; the spore-case was thrown off only when the former had acquired a length of 3 to 4 and the latter one of 2 to 3 lines, the capillary fibres still continuing at the origin of the rootlet. Soon afterwards a second leaf and a second rootlet were formed, both opposite to the laterally protruding spore-mass; after that new leaves and new roots spring up in distichous order between the older ones, the youngest in the centre. In twelve months the young plant, not yet fertile, shows the bilobed flat or rather concave trunk, 2 to 4 lines in diameter, with both ends strongly elevated, their edges already showing small masses of black decayed tissue (the remnants of the first year's growth). The leaves of these yearling plants, 10 to 15 in number, are 3 to 4 inches long, have abundant stomata, but as yet only a single very slender bast-bundle, median on the upper surface.

The species of *Isoëtes*, perhaps 40 to 60 in number (according to the views taken of the different forms, whether species or varieties), are distributed over the whole globe, apparently more abundant in the temperate than in the tropical zones. In North America we have 13 species, with 12 varieties, to which I add one from Cuba; from Mexico we have received as yet none. More are expected to be found when the attention of collectors is more earnestly directed to them.

Most of the species may be called water-plants, growing in stagnant or in slow-running water; a few are always submerged and are found out of water only in abnormal conditions, e.g. in unusually dry seasons. The majority are of amphibious growth, entirely or partially submerged dnring the wet seasons, in winter and especially in early spring; but at the growing season they partially get out of the water, leaving only their trunk and lower part of the leaves immersed. These species do not come to perfection when completely immersed, though they may not be entirely infertile; it seems that partial exposure to the atmosphere is necessary to their well-being. A variety of the amphibious species are the tidal ones, which are alternately emerged and submerged during the changes of the tides; they are found in the estuaries of some of our Atlantic rivers. Then we have a few species which we are justified in calling terrestrial, as we find them, when fully developed, on dry land; but it seems that for their germination and their growth in early spring they also require moisture and water; we therefore find them on low or flat grounds which may be overflowed in spring, or in springy localities, but they fully develope and become fertile only when out of water. *I. melanopoda*, which belongs to this class, normally matures in June or early in July, and its leaves wither before the end of that month; by keeping it immersed, however, I have kept it fresh and growing throughout the summer, but under these conditions it remained perfectly sterile. Those terrestrial species which grow on arid hills around the Mediterranean must require even less moisture, and are probably satisfied with temporary drenchings.

The submerged and the amphibious species are generally found, some in soft mud, others between gravel and stones; the amphibious ones generally in deep mud. Our terrestrial species grow mostly in heavy, retentive soil.

§ 4. *Systematic Arrangement.*

Our 14 species can be classed—

1. According to the developement of the trunk; thus we have 13 species, all our North American ones, with a *bilobed*, and only the single Cuban one with a *trilobed trunk*.

2. According to their mode of growth:

a. *Submerged species*, which normally always grow under water: *I. lacustris*, *I. pygmæa*, *I. Tuckermani*, *I. echinospora*, and *I. Bolanderi*.

b. *Amphibious species*, which grow in water but have their leaves usually emerged: *I. saccharata*, *I. riparia*, *I. flaccida*, *I. Engelmanni*, *I. melanospora*, and probably *I. Cubana*.

c. Terrestrial species, which grow during the greater part of their life on dry (or moist) land: *I. melanopoda*, *I. Butleri*, and *I. Nuttallii*.

These divisions seemed to be the most natural ones so long as but few species were known, and when other characters, such as the presence or absence of stomata, seemed to correspond with and to confirm them; but, since we know more species and more about them, we have learned that structural and biological characters do not always go together; and, moreover, that some species are in some forms submerged and in others almost amphibious (*I. echinospora*), and that some amphibious ones become sometimes almost terrestrial (*I. Engelmanni*). A less important objection is, that the biological characters cannot be made out in herbarium specimens.

3. According to the condition of the velum:

a. A partial or narrow velum has *I. lacustris*, *I. pygmæa*, *I. Tuckermani*, *I. echinospora*, *I. saccharata*, *I. Bolanderi*, *I. riparia*, *I. Engelmanni*, *I. Howellii*, *I. melanopoda*, and *I. Cubana*. In *I. Butleri* the velum is almost completely absent.

b. A complete velum has *I. melanopoda*, *I. flaccida*, and *I. Nuttallii*.

The anatomical structure of the leaves, viz., the presence or absence of stomata and of peripheral bast-bundles, furnishes us valuable characters, and, though somewhat difficult to ascertain and therefore less practical, may after all have to be placed in the first line, as it seems to correspond best with the essential characters of the plant.

4. According to the presence or absence of stomata in the leaves:

a. Without any stomata are only *I. lacustris*, *I. pygmæa*, and *I. Tuckermani*. The typical European *I. echinospora* also belongs here, but the different American forms of this species must be classed among the next, though some of them have only very few stomata, often difficult to make out.

b. With stomata (generally abundant): *I. echinospora* (American varieties), *I. saccharata*, *I. Bolanderi*, *I. riparia*, *I. melanospora*, *I. Engelmanni*, *I. Howellii*, *I. flaccida*, *I. melanopoda*, *I. Butleri*, *I. Nuttallii*, and *I. Cubana*.

5. According to the presence or absence of peripheral bast-bundles:

a. Without bast-bundles: *I. lacustris*, *I. pygmæa*, *I. Tuckermani*, *I. echinospora*, *I. saccharata*, *I. Bolanderi*, *I. riparia*, and *I. melanospora*.

b. With bast-bundles: *I. Engelmanni*, *I. Howelli*, *I. flaccida*, *I. melanopoda*, *I. Butleri*, *I. Nuttallii*, and *I. Cubana*.

The comparative size or the sculpture of the spores, and the number and length of the leaves, furnish no legitimate grounds for classification; still it may be mentioned here, that the largest macrospores (0.45 to 0.80 mill. in diam.) are found in *I. lacustris*, *I. Butleri*, and *I. riparia;* the smallest (0.25 to 0.45 mill.) in *I. melanopoda*, *I. flaccida*, and *I. Engelmanni* var. *valida*.

The largest number of leaves, 50 to 200, are observed in the last mentioned form, in *I. melanopoda* and in *I. Nuttallii;* the smallest number, 5 to 20, in *I. pygmæa*, *I. melanospora*, *I. saccharata*, and *I. Bolanderi*.

The longest leaves (15 to 25 inches long) we meet with in *I. Engelmanni*, *I. flaccida*, and *I. Cubana;* the shortest (½ to 3 inches long) in *I. pygmæa*, *I. melanospora*, and *I. saccharata*.

The following classification of our species is proposed as the best I can find, though by no means a faultless one.

I. **Trunk bilobed.**

A. Submerged species with quadrangular leaves, without, or in 4 and 5 with few or many stomata and without peripheral bast-bundles; velum incomplete.

1. *I. lacustris*. 2. *I. pygmæa*. 3. *I. Tuckermani*. 4. *I. echinospora*. 5. *I. Bolanderi*.

B. Amphibious species with abundant stomata in the quadrangular leaves.

* Without peripheral bast-bundles (these are intermediate between the submerged and the truly amphibious species.)

† Velum partial.

6. *I. saccharata*. 7. *I. riparia*.

† † Velum complete.

8. *I. melanospora*.

* * With peripheral bast-bundles.

† Velum partial.

9. *I. Engelmanni*. 10. *I. Howelli*.

† † Velum complete.

11. *I. flaccida*.

C. Terrestrial species, maturing when entirely out of water, with abundant stomata and peripheral bast-bundles in the nearly triangular leaves.

* Velum partial or almost wanting.

12. *I. melanopoda*. 13. *I. Butleri*.

* * Velum complete.

14. *I. Nuttallii.*

II. **Trunk trilobed,** numerous stomata and bast-bundles in the quadrangular leaves; velum partial.

15. *I. Cubana.*

§ 5. *Geographical Distribution.*

Only a small part of the North American continent has been well explored for Isoëtes, and there, from Massachusetts to the Chesapeake Bay, they appear abundant enough; farther south, and in the whole interior and western part of the continent, they have thus far been found only in a few localities. Some species are quite local, as is the case also with many species of the old world, while others are widely distributed. Our two northern species are identical with, or closely allied to, European forms, all the others are quite distinct from such, so that there is scarcely more than a generic analogy between the species of our middle and southern regions with the Mediterranean ones or those of other regions of the globe.

The old Linnean *Isoëtes lacustris* is the only species which has been found to extend from the Atlantic to the Pacific States, and it probably occupies a northern belt of the northern hemisphere, though it seems not to have been discovered as yet in Asia. The American forms allied to *I. echinospora*, the other North European species, are the most common in the belt of northern States as far west as Michigan, and have been detected also on the western slope of the Rocky Mountains. Of the others, *I. Engelmanni* extends from Massachusetts to Georgia and westward to Missouri, though thus far not found anywhere else west of the Alleghany Mountains. *I. flaccida* is peculiar to Florida and *I. Bolanderi* to the lakes of the western mountain chains, the Rocky Mountains as well as the Sierra Nevada. *I. melanopoda* occupies parts of the Mississippi valley from Central Illinois to Northeastern Texas, while *I. Nuttallii* is the only species found in the valley of the Columbia river. All the other species seem to be nearly or quite local, *I. pygmæa*, in the Californian Sierra, but most of them on the Atlantic border; thus *I. Tuckermani* occurs only near Boston, *I. saccharata* on streams emptying into the Chesapeake Bay, and *I. melanospora* only on that peculiar and, botanically, so interesting rock, the Stone Mountain of Georgia. Some species which seemed local have lately assumed a little wider range, though yet quite restricted; among these I mention *I. riparia* of the banks of the lower Delaware river, which occurs also farther north, and *T. Butleri*, first known only from the Indian Territory, now also found in Tennessee. There can be no doubt but that some of the apparently local species will yet be found in a more extended area, when botanists will include in their researches these obscure and inconspicuous plants.

From the warmer parts of North America we know only *I. Cubana*, from Cuba; none have yet turned up from Mexico.

The following table will explain itself.

	Total species and varieties.	I. lacustris.	paupercula.	I. pygmaea.	I. Tuckermani.	I. echin. Braunii.	robusta.	Boottii.	muricata.	I. Bolanderi.	I. saccharata.	I. riparia.	I. melanospora.	I. Engelmanni.	gracilis.	valida.	Georgiana.	I. Howellii.	I. flaccida.	I. melanopoda.	pallida.	I. Butleri.	immaculata.	I. Nuttallii.	I. Cubana.
Greenland	1					1																			
Nova Scotia	1					1																			
Maine	2					1						1													
New Hampshire	2	1				1																			
Vermont	4					1	1					1			1										
Massachusetts	8	1			1	1		1	1			1		1	1										
Rhode Island	2													1	1										
Connecticut	1													1											
New York	3	1				1								1											
Ontario	2					1						1													
Michigan	2	1				1																			
Pennsylvania	4					1						1		1		1									
New Jersey	4					1						1		1	1										
Delaware	3											1		1		1									
Maryland	1										1														
Virginia	1													1											
Georgia	2												1				1								
Florida	1																		1						
Tennessee	1																						1		
Illinois	1																			1					
Iowa	1																			1					
Missouri	1													1											
Indian Territory	2																			1		1			
Texas	1																				1				
Colorado	1		1																						
Utah	2					1				1															
Wyoming	1									1															
Idaho	1																							1	
Washington Territory	2									1														1	
Oregon	2																	1						1	
California	3		1	1						1															
Cuba	1																								1

8 species and varieties have been found in Massachusetts.
4 " " " " Pennsylvania and New Jersey.
3 " " " " New York and California.
2 " " " " 10 States, Territories, or Provinces.
1 " " " " 15 " " " "

§ 6. *Enumeration of the Species.*

I. Trunk bilobed.

A. Submerged, normally growing under water, only in unusually dry seasons coming above the surface; leaves quadrangular, without peripheral bast-bundles; velum incomplete.

* Without stomata.

1. I. LACUSTRIS, Lin. Leaves stout, rather rigid, obtusely quadrangular, acute but scarcely tapering, dark or olive-green, 10 to 25 in number, 2 to 6 inches long; sporangium orbicular to broadly elliptical, not spotted, with a rather narrow velum; ligula triangular, short or somewhat elongated; macrospores 0.50 to 0.80 mm.* in diameter, marked all over with distinct or somewhat confluent crests; microspores smooth, 0.035 to 0.046 mm. in the longer diameter.— Syst. Veg. I. 1753; Durieu Bull. Bot. Soc. France, 8, p. 164, 1861; Gray Man. ed. 5, p. 675.

Var. PAUPERCULA with fewer (10 to 18), thinner, shorter (2 to 3 inches) leaves and smaller spores (macrospores 0.50 to 0 66 mm. diam.; microspores somewhat granulated, 0.026 to 0.036 mm. long).

A northern species of Europe and America, generally gregarious on gravelly soil in the bottom of lakes under 1 to 4 or 5 feet of water, farther south only on mountains; maturing in Sept. and Oct. Catskill Mountains, N. Y. *Schweinitz*, Echo Lake, Franconia Mountains, N. H. *Tuckermann*, *Engelmann*; in Massachusetts, in Fresh Pond near Cambridge, *W. Boott* and Uxbridge, *J. W. Robbins;* Brattleborough, Vt., *C. C. Frost;* Saulte de Ste. Marie on Lake Superior. *Porter and Leidy.* The variety in Grand Lake, Middle Park, Colorado, over 8,000 ft. alt., *Engelmann,* and in Castle Lake near Mt. Shasta, California, 7,000 ft. alt., *C. G. Pringle.*—This is the original Linnean species, formerly confounded with others, and first clearly established by Durieu, l. c. It is always readily recognized by its rigid, rather thick, not gradually tapering dark green leaves, which do not collapse when taken out of the water, and by the size and sculpture of the spores. The variety *paupercula* is based on western mountain specimens, and is characterized by the smaller proportions of all parts, and especially of the (for the species) unusually small microspores. Durieu, l. c. 11, p. 101, distinguished a form with exceptionally large macrospores (0.70 to 0.80 mm. diam.) as *I. macrospora* from a single specimen from the Herb. Acad. N. S. Philad., with the label "Catskill Mountains" in the handwriting of Schweinitz; but others show sometimes spores of similar dimensions, e.g. specimens from Lake Superior; and such have also been found in Europe, though there the spores rarely reach a size of over 0.65 to 0.70 mm.

2. I. PYGMÆA, Engelm. One of the smallest species with a few (5 to 10) short (½ to 1 inch long) stout, rigid, bright green leaves, abruptly

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* I adopt for the smaller measurements the metrical system, which will gradually but surely supersede the old and clumsy method, while in the larger measurements, as the length of leaves, I still adhere to the foot and inch as the one yet best understood. The millimeter is, as is well known, equal to very nearly half a line.

tapering to a fine point, with very short, often almost square, epidermis cells; orbicular sporangium not spotted, with a narrow velum; macrospores 0.36 to 0.50 mm. thick, marked with minute, rather regular, distinct or rarely confluent warts; microspores 0.024 to 0.029 mm. long, almost smooth and brown.—Am. Naturalist, 8, 214.

Found only once, deeply immersed in a cold alpine stream on the eastern slope of the Mono Pass, California, 7,000 ft. alt., *H. Bolander*.—This curious diminutive species is a close ally to the last by the structure of the leaves and the mode of living, but is widely separated from it by the sculpture of the spores; the shortness of the epidermis cells is quite peculiar to it, and so are the close transverse partitions; the walls of the leaf and the dissepiments are thinner than in the last, consisting of only a few layers of cells. The minute tubercles of the macrospores are most distinct on the lower surface, but become sometimes confluent on the upper side.

3. I. TUCKERMANI, A. Braun in litt. A small plant with very slender tapering olive-green leaves (10 to 30 in number, mostly 2 to 3 inches long), the outer recurved, walls and partitions rather thick for the diameter of the leaf; sporangium mostly oblong, white or rarely brown-spotted, the upper third covered by the velum; macrospores 0.44 to 0.56 mm. diam., the upper segments marked with prominent, somewhat parallel and branching ridges, the lower half reticulated; microspores smooth or nearly so, 0.026 to 0.032 mm. long.—Engelm. in Gray Man. l. c. 676.

In several ponds and streams near Boston, maturing from August to October; first discovered by *E. Tuckermann*, 1848, in the Mystic river very near where it issues from the pond; in the same locality and in Mystic, Spy and Horn ponds, *W. Boott*, "always immersed in fresh water, sometimes only a few inches below the surface, often in places which are subject to a tide of almost two feet in height, generally gregarious and carpeting the bottom with an olive-green turf." The leaves are usually not longer than two or three inches, and, at least the outer ones, recurved; occasionally, in slender specimens, probably from deep water I have seen them straighter and over 5 inches long. The sculpture of the spores is very characteristic, wavy, somewhat branching ridges run from the three upper commissures in right angles; on the lower surface they interlace, covering it with an irregular network. Some specimens collected by Mr. Boott at the end of October seem to indicate a second growth, as within the circle of microspore-bearing leaves, and after the outer ones with their macrosporangia had fallen, an inner growth bearing macrosporangia was noticed. One of his specimens is of particular morphological interest, as it shows four heads or leaf-buds from the same healthy and vigorous trunk, three close together on top and a fourth on the side, separated from the others by a deep incision in the trunk. This division of the axis did not result from any proliferation of the leaves, but most probably from a lesion of the centre of vegetation and is of very rare occurrence in this genus, where the simplicity of the axis is so particularly marked (see above p. 358).

4. I. ECHINOSPORA, Durieu. One of the smaller species with 10 to 30 or 40 soft bright green or sometimes reddish leaves, gradually and regularly tapering from a thick base to a very slender elongated point absolutely without stomata, 2 to 4 or sometimes 5 inches long; sporangia orbicular to broadly oval, unspotted, with a narrow velum; macrospores 0.40 to 0.50 mm. thick, densely covered with delicate, erect, truncate, or slightly forked spinules; microspores 0.030 to 0.034 mm. long, almost smooth.—Bull. Bot. Soc. Fr. 8, 164.

Only in Europe from Northern Italy to Germany, France and England, extending to Lapland and Iceland, but apparently not in America.

In this country we have a series of forms which have been distinguished by eminent authority, especially on account of the presence of stomata so various in number and often so difficult to discover, and of a slight difference in the form and size of the microscopic spinules which cover the macrospores. I have thought best to unite them specifically with the European type, though it seems strange that in the European plant stomata should be absolutely absent, and it must remain subject to individual judgment, if not doubt, which view ought to be preferred. Nearest to the European true *I. echinospora* stands the var. *Braunii* and the other extreme is var. *muricata*, wide-ranging forms of a single type. The same difficulties, the same doubts, and the same solution, we find in studying some foreign forms and especially those allied to *I. velata* of the south of Europe.

* * Stomata few.

I. ECHINOSPORA, var. BRAUNII, Engelm. Rather small, with 13 to 15 green or reddish-green erect or spreading, rather short (3 to 6 inches long), tapering, soft leaves, generally with few stomata towards the tip only; sporangia orbicular to broadly elliptical, spotted, generally ½ or even ¾ covered by a broad velum; macrospores 0.40 to 0.50 mm. thick, rarely a little longer, covered with broad, retuse spinules, sometimes somewhat confluent, and then dentate or incised at tip; microspores 0.026 to 0.030 mm. long, smooth.—Gray Man. l. c. *I. Braunii*, Durieu l. c. 11, p. 101.

The most common species of our flora from New Jersey and Pennsylvania, northward and northwestward, sometimes on gravelly soil, at other places reported from soft mud, in ponds or slow-running streams, also near the banks of larger lakes or under the influence of tidewater, normally submerged from a few inches to several feet, in dry seasons sometimes getting out of water; associated with *Eriocaulon septangulare*, *Lobelia Dortmana*, *Sparganium*, *Scirpus*, *Eleocharis*, etc. New Jersey: in tidewater of Tom's river, a slender long-leaved form, *C. F. Parker*, *C. E. Smith*, and others; in a lake in Morris Co., *T. C. Porter*. Pennsylvania: Montrose, Susquehanna Co., *A. P. Garber;* Great Lake, Pocono Mountain, *Porter & Canby;* Presque Isle, Erie, *A. P. Garber*. New York: Catskill Mountains in the lake near the hotel, *G. W. Clinton;* Round Lake above Bolton, west of Lake George, on white sand, and in Lake Placide, *L. Lesquereux;* Luzerne Lake and in Niagara river below Buffalo, *G. W.*

Clinton; at the head of Goat Island, Niagara, between stones, *G. Engelmann*; Oneida Lake, *J. A. Paine*; in Oswego river, *F. Pursh*, probably (see p. 353). Massachusetts: Mystic Pond near its lower end, gregarious in soft mud in 1 foot of water, also in other parts of the same pond, and in Spot, Spy and Horn ponds, on sandy bottom, all near Boston, *W. Boott*; Hammond's Pond, *W. G. Farlow*; Concord brook, gregarious, on firm bottom, *H. Mann*; Beaver Pond near Beverly, *J. L. Russell*; Uxbridge, in Grafton Pond and several other ponds, *I. W. Robbins*. Vermont: Mt. Mansfield, in the Lake of the Clouds, *C. G. Pringle*, *H. Mann*, on gravelly bottoms, 1 to 2 feet deep; Lake Dunmore, *A. W. Chapman*. New Hampshire: Lake Winnipiseogee, in mud with *Gratiola aurea*, *Eriocaulon*, etc., *G. Engelmann* (these specimens were the types of Durieu's *I. Braunii*), *H. Mann*, *W. Boott*; Echo Lake in the Franconia Mountains (where Mr. Tuckerman and myself had found *I. lacustris*), *W. Boott*. Maine: Moose Lake on Kennebunk river, *C. E. Smith*. Nova Scotia, Shelburne, *T. P. James*. Greenland, in the south, "Tessermint," *I. Vahl* (perhaps this is the true *I. echinospora*; I could not well analyze the small and poor specimen in my possession). Westward the species has been found in Western Canada (Ontario) near Hastings and in a lake northeast of Belleville, on a muddy bottom, *J. Macoun*. Michigan: Bellisle in Detroit river, *H. Gillman*. Utah: Lake at the head of Bear river in the Uintah Mountains, at 9,500 feet alt., *S. Watson*; this is the most western and highest, quite isolated, locality known to me.

This form is most closely connected with the European type; the leaves are perhaps not quite so finely tapering; stomata can always be found, at least near the tip of the leaf; the sporangia, white in the type, are spotted with brown sclerenchym cells; the macrospores I cannot distinguish either in size or sculpture; the microspores I find a little smaller. I may state here that the name of *I. Braunii* is preoccupied, as it has already been given to one of the two species of the Tertiary deposits, the well marked spores of which have been discovered in the German Brown Coal strata; Prof. Braun therefore proposed for our plant, if it should eventually be considered distinct, the name of *I. ambigua*.

Var. ROBUSTA, Engelm., similar to the last, but much stouter, with 25 to 70 leaves, 5 to 8 inches long, with abundant stomata all over their surface; velum covering about one-half of the large, spotted sporangium; macrospores 0.36 to 0.55 mm. thick, with the sculpture of the last; microspores the same as in last.

In Lake Champlain, on the north end of Isle La Motte, on a firm sandy soil with silt, in 1 to 2 feet of water, *C. G. Pringle*. Larger and stouter than any form of the last, but principally distinguished from it by the abundance of stomata.

Var. BOOTTII, Engelm. l. c. Leaves erect, soft, bright green, fewer (12 to 20) short (4 to 5 inches long); stomata, mostly few, near the tip; sporangia nearly orbicular, pale-spotted, ⅔ or more covered by the broad velum; macrospores 0.39 to 0.50 mm. thick, with longer and slenderer delicate, generally simple spinules; microspores 0.026 to 0.030 mm. long. —*I. Boottii*, A. Braun in litt.

Near Boston, in the Round Pond, Woburn, 2 to 3 feet under water, and in the brook of Tofit Swamp, Lexington, sometimes out of water, *Wm. Boott.* Very striking on account of the delicate green color of its soft leaves, and the long and slender spinules of the spores.

Var. MURICATA, Engelm. l. c. Leaves (15 to 20) long (6 to 12 inches), flaccid, bright green, with very few stomata; sporangium broadly oval, pale-spotted, about half covered by the velum; macrospores a little larger (0.40 to 0.58 mm. thick), with shorter and more confluent, therefore sometimes almost crest-like spinules: macrospores slightly rough on the edges, 0.028 to 0.032 mm. long.—*I. muricata*, Durieu l. c.

In the shallow and more rapid parts of Woburn creek, and in Abajona river, the main source of Mystic Pond, near Boston, scattered over a clean gravelly bottom and always submerged, *W. Boott.* Remarkable for its long flaccid leaves and the shorter spinules of the macrospores, which form sometimes crests so that Durieu could compare it with *I. riparia.*

5. I. BOLANDERI, Engelm. One of the smaller species with erect, soft, bright green leaves tapering to a fine point, 5 to 20 or 25 in number, 2 to 4½ inches long, with thin walls and partitions, and generally not many stomata; sporagium broadly oblong, mostly without any spots, with a narrow velum; ligula triangular; macrospores 0.30 to 0.40 or rarely 0.45 mm. thick, marked with minute low tubercles or warts, rarely confluent to wrinkles; microspores 0.026 to 0.031 mm. long, generally spinulose; rarely, in the Rocky Mountain form, smooth, deep brown.—Am. Naturalist, 8, 214.—*I. Californica* Engelm., name only in Gray Man. l. c.

A western mountain species, found gregarious in ponds and shallow lakes of the Sierra Nevada of California, northward to the Cascades and eastward to the Rocky Mountains: in little pools on meadows in the upper Tuolumne valley 9,000 to 10,000 feet alt., on Mt. Dana, on the Mono trail, in Mary's Lake near the summit, 7,000 feet alt., in small lakes about Cisco 4,500 to 5,000 feet alt, "mostly gregarious in mud covering gravel, in 1 or 2 feet of water," *H. Bolander;* Ice Lake, near Soda Spring station, 7,500 feet alt., with *Menyanthes trifoliata. Engelmann;* in many lakes of the high sierras, reported by A. Kellogg; on Mt. Adams, Washington Terr., *W. N. Suksdorf,* in the soft muddy bottom of a shallow pond near the falls of the Yellowstone river in Wyoming, nearly covering the muddy bottom, partly emerged near the banks, *C. C. Parry;* in a subalpine lake at Alta, Wasatch Mountains, Utah, *M E. Jones*, and in a lake in the Gunnison region, Western Colorado, covering ten acres of ground with *Menyanthes*, *T. S. Brandegee.*—This species has much the appearance of *I. echinospora* var. *Bootti*, with its soft bright green leaves; the stomata are often difficult to make out.

B. Amphibious, partially emerged, submergedonly in the earlier period of their growth or temporarily; stomata always present.

* Without peripheral bast-bundles; intermediate between the submerged and the truly amphibious species.

† Velum partial.

6. I. SACCHARATA, Engelm. A small plant, usually with a flat, depressed trunk; leaves subulate, olive-green, spreading, 10 to 20 in number, 2 to 3 inches long; sporangium oblong, spotted, with a narrow velum; ligula triangular; macrospores 0.40 to 0.47 mm. thick, covered with very minute distinct or sometimes a little confluent warts; microspores papillose, 0.024 to 0.028 mm. long.—Gray Man. l. c.

On the banks of the Wicomico, below Salisbury, and of the Nanticoke rivers which empty into the Chesapeake Bay, eastern shore of Maryland, above salt water, scattered on a thin stratum of mud covering a bed of gravel, overflowed by the tides, in company with *Sagittaria pusilla*, *Eriocaulon*, *Tillaca simplex*, *Micranthemum Nuttallii*, etc., *W. M. Canby.* The trunk is in this species unusually flat, about half as thick as it is wide in the direction of the groove; about one inch of the base of the leaves is pale, and covered with mud agitated by the tides, the upper part is olive-green and when out of water apt to be borne down by mud; stomata abundant; macrospores as if sprinkled over with minute white grains of sugar, whence the name.

7. I. RIPARIA, Engelm. A larger plant with slender but rather rigid deep green leaves (about 15 to 30 in number), 4 to 8 inches long, rarely longer; stomata numerous, dissepiments thick, consisting of about 4 layers of cells; sporangia mostly oblong, distinctly spotted by groups of brown sclerenchym cells, $\frac{1}{4}$ or rarely $\frac{1}{3}$ of it covered by the velum; macrospores among the largest, 0 45 to 0.65 mm. in diam., marked with jagged crests isolated, or anastomosizing, especially on the lower surface, which thus becomes somewhat reticulated; microspores more or less tuberculated, 0.028 to 0.032 mm. long.—Flora, Regensb. Mar. 31, 1846; Am. Jour. Arts & Sci. 3, p. 52, 1847: Gray Man. l. c.

On the banks of the lower Delaware river between the limits of the tides in mud covering gravel, from Burlington, *T. A. Conrad*, to Wilmington, *W. M. Canby*, and especially about Philadelphia, where *Nuttall* first discovered and *W. S. Zantzinger*, *E. Durand* and the later botanists have abundantly collected it, associated with *Elatine*, *Limosella*, *Micranthemum*, *Sagittaria pusilla*, etc.; also in millponds and still parts of streams in New England, Uxbridge, *J. W. Robbins*, Brattleborough, *C. C. Frost*, and northward, maturing in August and September. — Near *I. lacustris*, with leaves as dark green and almost as rigid, and with spores approaching it in size and sculpture, but readily distinguished by its stomata and by the spots on the sporangium; from *I. echinospora* var. *Braunii*, with which smaller forms it may possibly be confounded; it can always be known by the darker, stiffer leaves and especially by the character of the spores. Some of the Uxbridge specimens, entirely submerged 2 to 4 feet deep in water, have slenderer and longer (even 12 inches) leaves. The trunk, mostly thick, I have once found 3-lobed. Germinating spores and young plantlets were found in June by Mr. Durand indicating germination in spring and early summer.

Farther northward, in Maine, *J. W. Chickering*, and in Canada West, Crow river, Hastings Co., *J. Macoun* (here in running water with *Brasenia* and *Potamogeton*), a form occurs with very few stomata on leaves and apparently two weak bast-bundles, an upper and a lower one, very pale spots on the sporangia and smoothish microspores, which might be designated as var. *Canadensis*, but too little is known about it as yet to form a definite opinion.

† † Velum complete.

8. I. MELANOSPORA, Engelm. One of the smallest species, with a flat, only slightly bilobed trunk; leaves few (5 to 10, 2 to 2½ inches long), distichous, slender, tapering, light green, spreading; sporangium orbicular or almost obcordate, ½ to 1 line long, entirely covered by the velum, unspotted; ligula short-triangular, obtuse, or about semi-orbicular; macrospores 0.35 to 0.45 mm. in diameter, roughened with distinct or rarely somewhat confluent warts, dark colored; microspores 0.028 to 0.031 mm. long, smoothish or slightly papillose.—Transact. St. Louis Acad. Sci. 3, p. 395, note.

Stone Mountain near Atlanta, Georgia, covering the bottom of shallow excavations on the naked granite surface, a few inches deep and a few feet in diameter, holding about one inch of light, black soil and at best a couple of inches of water supplied only by rains and dews, and completely dried up and baked for weeks or months under the action of the glaring southern sun on the bare rock, when only the little shrivelled trunks with their black withered matted roots remain, to revive under a fresh supply of autumnal rains; with *Amphianthus pusillus*, discovered by *W. M. Canby*, observed since by *A. Gray* and myself; maturing in May and June. A cake of them taken home with me began to sprout soon after being moistened, and, vegetating in the room through winter, fully developed in early summer, and afforded a fine opportunity for studying this curious little species, interesting on account of its native locality, its endurance of drought, its mode of growth and the phyllotactic arrangement of its leaves, its entire velum and its dark spores; it seemed to thrive best when only the base of the leaves was covered with water. The trunk is unusually flat and only slightly grooved underneath and on one side, only about ½ to 1 line thick and 2 to 4 lines in the longer and not much more than half as much in the shorter diameter; distichous leaves soft and slender, their dissepiments consisting of only two layers of cells. The sporangia, ½ to ¾ line wide, readily separate from the leaf-bases, so that they are sometimes found adhering to the trunk after the leaf itself has already fallen away. The macrospores, only 8 to 20 in each sporangium, are black when moist and dark gray when dry; in some I find the warts much smaller than in others, but never wanting; microspores also quite dark brown.

* * With peripheral bast-bundles.

† Velum partial.

9. I. ENGELMANNI, A. Braun. Our largest species with numerous (25 to 100) long (9 to 20 inches or more) light green leaves with abundant stomata; sporangium usually oblong to linear-oblong, unspotted; velum narrow; ligula elongated from a triangular base; macrospores 0.40 to 0.52 mm. thick, delicately honeycomb-reticulated; microspores 0.024 to 0.028 mm. long, generally smooth.—Flora l. c.; Am. Jour. l. c.; Gray Man. l. c.

Var. GRACILIS, Engelm. Often submerged, with fewer (8 to 12) leaves, 9 to 12 inches long; the bast-bundles sometimes quite small, or only two of them.—Gray Man. l. c.

Var. VALIDA, Engelm. The stoutest of all our species; leaves 50 to 100 or even 200, 18 to 25 inches long, keeled on the upper side; sporan. gium often linear-oblong (4 to 9 lines long), $\frac{1}{3}$ or often $\frac{1}{2}$ or even $\frac{2}{3}$ covered by the broad velum; macrospores rather smaller, 0.32 to 0.48 mm. thick; microspores 0.024 to 0.027 mm. long, spinulose,—Gray Man. l. c.

Var. GEORGIANA. Similar to the type; leaves few (in the only specimens seen 15, 10 to 12 inches long), rather slender; oval sporangium with narrow velum; macrospores larger, 0.48 to 0.56 mm. thick; microspores 0.028 to 0.031 mm. long, smooth.

In ponds and ditches, immersed in mud, rarely found in slow-running streams, in company with the ordinary vegetation of such localities, *Bidens*, *Polygonum*, *Lycopus*, *Carices*, *Leersia*, etc.; mature in summer; probably throughout the middle States, but thus far only found — from Massachusetts: Arlington brook, Alewife brook, West Cambridge brook, Woburn, *Wm. Boott*. Rhode Island: Newport, *W. G. Farlow*. Connecticut: Meriden, *F. W. Hall* — to New York: Peekskill, *W. H. Leggett*. New Jersey: *E. Durand*, *C. F. Austin*, and others. Pennsylvania, Bethlehem, *C. J. Moser*, *E. Durand*, *S. Wolle;* Delaware Water-Gap, *S. W. Knipe;* Darby, *J. G. Hunt;* Philadelphia, *E. Durand*, *C. E. Smith*, and others. Delaware: *Wm. M. Canby*, *A. Commons*. Virginia: Salt Pond Mountain, with *Parnassia asarifolia*, *W. M. Canby*. Missouri: St. Louis, *N. Riehl* and *G. Engelmann*, 1842, in a single locality, where it was soon afterwards destroyed by cultivation: not found otherwise west of the Alleghany Mountains. Var. *gracilis* seems to be a northern form: Brattleborough, in Clark's Pond, *C. C. Frost;* Colebrook's, in a shallow stream with gravelly bottom, *J. W. Robbins;* New Haven, in fresh water on a tidal shore, *D. C. Eaton;* Newport, *Bridges*, *G. Thurber;* Passaic river, near low-water mark, *J. Ennis*. Var. *valida* was discovered in Pennsylvania near Warrior's Mark, Huntington Co., and Smithville, Lancaster Co., *T. C. Porter;* and in Delaware, Wilmington, *W. M. Canby*. Var. *Georgiana* comes from a mountain stream, Georgia, the Horseleg creek, a tributary of Coosa river, Floyd Co., in slow-flowing water about a foot deep. *A. W. Chapman.*

The trunk of this species is larger than I have seen it in any other, and more variable in form; sometimes it is quite flat and over one inch wide, especially in var. *valida*, or it is thick; and I have seen it even twice as high as it was wide, $4\frac{1}{2}$ lines wide in the largest transverse diameter and 7 lines high; this, however, is a very unusual form. The plant is submerged in spring with the leaves partly floating; later, when the water recedes, the older leaves are spread out on the mud, but the later growth becomes erect; var. *gracilis* is often more or less submerged, and its weakly developement is probably owing to this circumstance, while var. *valida* is the stoutest form we have, and one of the stoutest in the whole genus, perhaps only *I. Malinvcriana* of the rice fields of Lombardy surpassing it. A very small form, only 5 inches high, has been collected in a springy place on a rocky hillside near Wilmington, Del., by A. Commons, otherwise not distinct. The Georgia variety, characterized by its larger spores, ought to be further studied. In my Missouri specimens I find, among many of the ordinary type with white sporangium, a few where this organ is uniformly brown, not spotted. The dissepiments of the leaves consist, the median of 3 to 4 and the transverse one of 2 to 3 layers of cells. The well marked reticulation of the macrospores is formed of very thin fragile laminæ, not of thick ridges as in some other species.

10. I. Howellii, Engelm. n. sp. Middle sized, leaves (10 to 25) bright green (5 to 8 inches long) with thick dissepiments; sporangium oval ($1\frac{1}{2}$ to $2\frac{1}{2}$ lines long), unspotted, $\frac{1}{4}$ to $\frac{1}{2}$ covered by the velum; subulate ligula as long as sporangium; macrospores 0.43 to 0.48 mm. in diam., rough, with prominent rounded single or sometimes confluent tubercles.

On border of ponds at the Dalles of the Columbia, Oregon, *J. & T. J. Howell*, 1880, not quite mature in June. — I insert this species which has just been communicated to me through the kindness of Mr. G. E. Davenport, while the manuscript is in the hands of the printer: this must excuse some discrepancies in the foregoing pages, where no reference could be made to it. The new species is distinguished from the similar *I. Bolanderi* by the longer leaves, larger more prominently marked macrospores, and especially by the distinct peripheral bast-bundles, which place it near the foregoing one, by the thick dissepiment consisting of 4 to 6 layers of cells, and by the unusually narrow and long ligula; the tubercles of the spores are quite prominent, as high as they are wide, rounded at top; microspores light brown, smooth. — Among the specimens of this species, and probably collected with it, I find a single one similar in the structure of the leaf, but without a trace of a velum, the sporangium being entirely naked and only attached by the median line to the leaf base; it is unfortunately immature, and can only be indicated as a probably new species, *I. nuda*. This would not be the first instance of two species growing together in the same pond or lake; in Mystic Pond we find *I. Tuckermani* and *I. echinospora* var. *Braunii*, in Echo Lake the latter and *I. lacustris*, and in Europe not rarely this together with *I. echinospora*.

† † Velum complete.

11. I. FLACCIDA, Shuttleworth, in sched. A slender plant of light green color; leaves often very long, 10 to 35 in number, 15 to 24 inches long, sometimes entirely submerged, or partly floating on the surface, or entirely emerged; sporangia oval, 2 to 3 lines long, entirely covered by the velum; macrospores 0.30 to 0.42 mm. in diam., covered with many or rarely few comparatively large flattish tubercles, distinct or confluent into labyrinthiform wrinkles; microspores not seen. — A. Braun in Flora l. c.; Amer. Jour. l. c.; Chapm. Fl. So. States, p. 602.

Var. RIGIDA, a smaller form with still more slender, erect, dark green leaves (about 10 to 15 in number, 5 to 6 inches long).

Var. CHAPMANI larger, light green, leaves floating (about 30, 18 inches long); sporangium orbicular; spores larger, macrospores 0.44 to 0.55 mm. in diam., marked as the type, or, especially on the upper side, almost smooth; microspores 0.027 to 0.030 mm. long, slightly papillose.

Florida, on the muddy bottom of lakes or swamps, first found by Dr. Rugel in Lake Immonia, north of Tallahassee; lately rediscovered by A. P. Garber in a hummock. near Manatee, on the muddy border of shallow ponds in water from a few inches to 1½ feet deep, the long leaves floating or spread out on the mud, the inner ones erect; mature in April and May, disappearing in June. Var. *rigida* was found by the same collector on the wet borders of Lake Flirt, not far from Lake Okeechobee, in August, entirely emersed and erect. Mr. A. H. Curtiss seems to have met with a similar form in a muddy swamp on Indian river; none of all of these had any mature microspores. Var. *Chapmani* was discovered by A. W. Chapman near Mariana, West Florida, filling a lakelet of pure limestone water about one foot deep, formed by one of those (in that region so common) subterranean streams, where it comes to the surface before emptying into Chipola river, together with *Nasturtium lacustres;* but the *Isoëtes* has not been seen in it since: its larger macrospores, sometimes quite smooth, distinguish it from the other forms. — This peculiar species, the only one thus far found in Florida, is distributed over the whole State. It cannot be classed with the submerged species, for, though evidently often in deep water, the leaves elongate, seek the surface and float on it. The closed velum and the peculiar sculpture of the macrospores readily distinguish it from its allies.

C. Terrestrial species, maturing when entirely out of water, with abundant stomata and peripheral bast-bundles, thick dissepiments, and small air cavities in the nearly triangular leaves.

* Velum partial or almost wanting.

12. I. MELANOPODA, J. Gay. Polygamous; trunk subglobose deeply bilobed; leaves slender, stiff, erect, bright green, usually black at base (15 to 60 in number, 5 to 10 or rarely even 18 inches long); sporangia

mostly oblong (2 to 4 or even 5 lines long), spotted, with narrow velum, ligula triangular-subulate; macrospores among the smallest in the genus, 0.25 to 0.40 in diam., with depressed tubercles often confluent into worm-like wrinkles, or almost smooth; microspores also smaller than usual, 0.023 to 0.028 or rarely 0.030 mm. long, spinulose.—Durieu in Bullet. l. c.; Gray Man. l. c.

Var. PALLIDA. A larger plant, leaf-bases pale, velum usually much broader, covering ¼ or ⅓ of the sporangium; macrospores only 0.30 to 0.35 mm. thick.

An exclusively western species, in low prairies and fields overflowed with at least one inch of water in spring, or in shallow ponds which dry up in summer, in stiff clayey soil, in company with the ordinary vegetation of such localities, e.g. *Nasturtium sessiliflorum*, *Hypericum mutilum*, *Elatine*, *Penthorum*, *Ludwigia*, *Ammannia*, *Alisma*, *Juncus*, etc., from northern and central Illinois, Ringwood, *G. Vasey;* Athens, Menard Co., *E. Hall:* to Clinton, Iowa, *G. Vasey*, the Indian Territory, in low places in the saline flats near Limestone Gap, *G. D. Butler*, and to the wet pine woods in Hempstead Co. and about Houston, Texas, where the variety occurs, *E. Hall.* Maturing in June or beginning of July.—Mr. Hall was accidentally led to the discovery of this plant on his farm in 1853 by finding its trunks and spores in turning up the soil for brick-making; he has since made many interesting observations about it; he does not find it every year, thus in 1877 there was none at all in localities where before and since it abounded, though the season was wet; another time he found it copiously only in plow furrows in a meadow, and none elsewhere; in wet seasons, when the water is deeper than usual about the plants, the leaves become longer, more flaccid, and even decumbent, and the spores mature later or not at all. In ordinary seasons the leaves disappear entirely in July and nothing but the trunks remain, and about them the numerous spores, both of which are eagerly sought after by mice and other animals. The spores germinate whenever sufficient rain falls in the later summer months, and perfect meadows of young plantlets can be observed in wet autumns. Sometimes the plants are seen as fresh in September as in May, and already 4 to 6 inches high, and in 1865 they were so much favored by the season that a second crop was gathered in November with perfectly mature spores; but it is scarcely probable that these could have been seedlings of the preceding summer, though Mr. Hall is inclined to think so.

The polygamous character of this species has been alluded to on page 363. I will here only add, that a number of monœcious specimens show a preponderance of one or the other sex, and that in a few I have found leaves, which bear male or female sporangia, irregularly mixed.

The dissepiments of the leaves consist of 6 to 9 layers of cells, the lower median being the thickest. Besides the normally 4 peripheral bast-bundles we find here often several smaller accessory ones, which increase the rigidity of the leaves. In no species have I seen the macrospores so variable in size in the same sporangium; large and small ones are indiscriminately mixed; and they are also remarkably variable in their sculpture, showing distinct or confluent vermiculate tubercles, or a nearly smooth surface; the dividing ridges or commissures are very prominent and smooth. The leaf-bases of the typical form of this species are black and shining, and justify the name given by that zealous botanist, Jacques Gay, who in his 75th year was still anxious and able to climb the high mountains in the centre of France, to study in their lakes the two European species which had just then become prominent through the labors of his friend Durieu de Maisonneuve, and who left us such a vivid description of his hardships, excitements and pleasures on that trip (Bull. S. B. F. vols. 8 & 9); death prevented him from publishing it, but his name remains connected with it. Now and then a paler specimen is seen, and the Texan form is always pale, and distinguished also by its broader velum.

13. I. BUTLERI, Engelm. Diœcious, smaller than the last, with a subglobose trunk and thinner and more rigid bright green leaves, 8 to 12 in number and 3 to 7 inches long; sporangium usually oblong, spotted, without any or with a very narrow velum; ligula subulate from a triangular base; macrospores larger than in last, 0.50 to 0.63 mm. in diameter, similarly marked with knobs or warts, distinct or sometimes confluent; microspores 0.028 to 0.034 mm. long, dark brown, papillose. — Bot. Gazette, 1878, p. 1.

Var. IMMACULATA. Larger, leaves sometimes as many as 60, 6 to 9 inches long; sporangium without spots; macrospores rather smaller, 0.40 to 0.56 mm. in diam.; microspores 0.029 to 0.031 mm. long, spinulose.

In the saline flats (called alkali flats, but impregnated with sulphates) of the Indian Territory, near Limestone Gap, between Arkansas and Red rivers, associated with the few coarse plants which can live in those localities overflowed in winter and spring, and baked hard in summer and autumn, such as *Iva angustifolia*, *Ambrosia psilostachya*, *Arenaria Pitcheri*, and with *Isoëtes melanopoda*, but in rather drier localities than this; maturing in May and June, *G. D. Butler*. The variety near Nashville, Tenn., in cedar barrens, in damp places on the limestone flats, with *Leavenworthia*, *Talinum*, *Sedum pulchellum*, *Schœnolirion*, several *Junci*, etc., *A. Gattinger*.—This species, also peculiar to the Mississippi Valley, is quite unique in this genus by its dioicity, though its nearest ally, the last mentioned one, approaches it. From this it is readily distinguished by the absence of the velum, by the deep brown color of the microspores and the larger size of the macrospores; in these last I notice the peculiarity that the ridges themselves which separate the faces of the spores are also more or less tuberculated, while in other species they are quite smooth.

* * Velum complete.

14. I. NUTTALLII, A. Braun in Herb. Similar to the last two species, with an almost globose slightly grooved trunk and 20 to 60 slender bright green leaves, 3 to 9 inches long, with only 3 peripheral bast-bundles; spo-

rangium oblong or oval, entirely covered by the velum; macrospores very variable in size, between 0.25 and 0.50 mm. thick, densely covered with minute but prominent rounded warts, or, rarely, almost smooth; microspores 0.025 to 0.028 mm. long, papillose, brown. — Engelm. in Am. Nat. 8, p. 215; *I. opaca*, Nutt. in Hb. Ac. Phil.

On damp prairie flats or springy declivities in the valley of the Columbia river, *Nuttall;* abundant about Silverton in the Wallamette valley, *E. Hall*, No. 693; at Milwaukee, Oregon, *J. Howell* (with almost smooth macrospores); Klickitat Co., Washington Terr., on Kamass Prairie and at the base of Mt. Adams, 2,100 feet alt., *W. N. Suksdorf;* eastward on Kamass Prairie of the Cœur d'Aleines in Western Idaho, *Ch. A. Geyer.*—The closed velum and the much smaller warts of the macrospores distinguish this readily from the two other terrestrial speeies; it is the only species on which I observe constantly only 3 peripheral bast-bundles, one on each of the three edges, the upper middle one being absent. The median dissepiment of the leaves consists of 8 or 9 and the transverse one of 6 to 7 layers of cells.

II. **Trunk trilobed,** bast-bundles and numerous stomata in the quadrangular leaves; velum partial.

15. I. Cubana, Engelm. One of the larger species; leaves 30 to 40, 15 inches long, fresh green, with 6 bast-bundles; sporangia oblong, unspotted; velum very narrow; macrospores 0.30 to 0.40 mm. thick, marked with coarse round depressed, never confluent tubercles; microspores 0.024 to 0.027 mm. long, papillose, pale.—Sauvalle Fl. Cub., p. 203, name only.

On the bottom of rivulets in the pine woods of Eastern Cuba, *Chas. Wright*, probably floating. — This is the only American species north of the Equator with a trilobed trunk; it compares most closely with the East Indian *I. Coromandelina* according to A. Braun's observation. The roots form 3 distinct bundles from the 3 grooves; the bast-bundles are found at the four intersections of the dissepiments with the outer walls and at the two upper edges of the leaf.

TABULATED CHARACTERS OF THE NORTH AMERICAN ISOËTES.

	Vegetation.	Trunk lobes.	LEAVES. Number.	LEAVES. Length inches.	Stomata.	Bast-bundles	Velum.	Sporangium	MACROSPORES. Diameter, millimeters.	MACROSPORES. Surface.	MICROSPORES. Length, millimet	MICROSPORES. Surface.	NATIVE COUNTRY.
1. *I. lacustris*	subm.	2	10—25	2—6	0	0	*n.*	*w.*	0.60—0.80	Cristate................	0.035—46	Smooth...	North'n N. York to Lake Sup'r
var. *paupercula*	"	2	10—18	2—4	0	0	*b.*	*w.*	0.62—0.66	"	0.026—36	Nearly do.	Rocky Mountains & California
2 *I. pygmæa*	"	2	5—10	½—1	0	0	*n.*	*w.*	0.36—0.50	Minutely tuberculated	0.024—29	" "	Californian Mountains.
3. *I. Tuckermani*	"	2	10—30	2—3	0	0	*b.*	*sp.*	0.44—0.56	Cristate above, reticulate below	0.026—32	Smoothish	New England.
4. *I. echinospora* var. *Braunii.*	"	2	15—30	3—6	few	0	*b.*	*sp.*	0.40—0.50	Spinulose	0.026—30	Smooth. {	Pennsylvania northward and northwestward and to Utah.
var. *robusta*	"	2	25—70	5—8	many	0	*b.*	*sp.*	0.35—0.55	With longer slenderer spines	0.026—31	Smooth...	New England.
var. *Boottii*	"	2	12—30	4—5	few	0	*bb.*	*sp.*	0.40—0.50	" " "	0.026—3	Smoothish	"
var. *muricata.*	"	2	15—30	6—12	"	0	*bb.*	*w.*	0.44—0.58	With shorter confluent spines	0.028—32	"	"
5 *I. Bolanderi*	"	2	5—20	2—4½	"	0	*b.*	*w.*	0.30—0.45	Sparsely and minutely tuberculated......	0.026—31	Papillose.	Calif., Oreg., Rocky Mount'ns.
6. *I. saccharata*	amph.	2	10—20	2—3	many	0	*n.*	*sp.*	0.40—0.47	Minutely tuberculated	0.024—25	"	Maryland.
7. *I. riparia*	"	2	15—30	4—8	"	0	*b.*	*sp.*	0.44—0.65	Cristate	0.028—34	"	Pennsylvania to New England.
8. *I. melanospora.*	"	2	5—10	2—2½	"	0	*c.*	*w.*	0.35—0.45	Minutely tuberculate	0.027—30	Smoothish	Georgia.
9. *I. Engelmanni.*	"	2	25—100	9—20	"	4	*n.*	*w.*	0.40—0.52	Reticulated	0.024—28	"	Delaware to N.Eng.&Missouri.
var. *gracilis*	"	2	8—12	9—12	"	4	*n.*	*w.*	0.38—0.48	"	0.024—28	"	Pennsylvania to New England.
var. *valida*	"	2	50—200	18—25	"	4	*b.*	*w.*	0.32—0.48	"	0.024—27	Spinulose.	Pennsylvania.
var. *Georgiana*	"	2	15	10—12	"	4	*n.*	*w.*	0.48—0.56	"	0.028—31	Smooth.	Georgia.
10 *I. Howellii*	"	2	10—25	5—8	few	4	*b.*	*w.*	0.43—0.48	Coarsely tuberculated	...	....	Oregon.
11. *I. flaccida.*	subm.?	2	10—35	15—21	many	4	*c.*	*w.*	0.30—0.42	Coarsely tuberculated, tub. often confluent	....	.	Florida.
var. *rigida.*	amph.	2	10—15	5—6	"	1	*c.*	*w.*	0.30—0.38	" " "	...	.....	"
var. *Chapmani.*	"	2	30	18	"	4	*c.*	*w.*	0.44—0.55	" often smooth above	0.027—30	Papillose.	"
12. *I. melanopoda*	terr.	2	15—60	5—16	"	1+	*n.*	*sp.*	} 0.25—0.40	" " " " {	0.023—30	Spinulose.	Illinois to Indian Territory.
var. *pallida.*	"	2	10—15	8—15	"	4	*b.*	*sp.*			.....	.....	Texas.
13. *I. Butleri*	"	2	8—12	3—7	"	4	*nn.*	*sp.*	0.50—0.63	Minutely tuberculated	0.025—34	Papillose.	Indian Territory.
var. *immaculata*	"	2	20—60	6—9	"	1	*nn.*	*w.*	0.40—0.56	do. or nearly smooth	0.029—31	Spinulose	Tennessee.
14. *I. Nuttallii*	"	2	15—60	3—9	"	3	*c.*	*w.*	0.32—0.52	Minutely tuberculated	0.025—28	Papillose	Western Idaho to Oregon.
15. *I. Cubana*	amph.?	3	30—40	15	"	6	*n.*	*w.*	0.30—0.40	Coarsely tuberculated	0.024—27	"	Cuba.

EXPLANATIONS.

VEGETATION — submerged, amphibious, or terrestrial.
VELUM — *n* means narrow; *nn.* very narrow; *b.* broad; *bb*, very broad; *c.* closed.
SPORANGIUM — *w* means white or unspotted; *sp*, spotted with dark sclerenchym-cells.

Auroral Phenomena on the evening of Sept. 12, 1881.

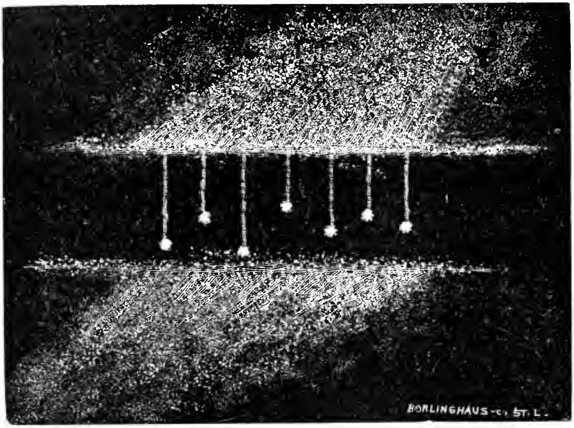
By E. A. Engler.

Washington University, St. Louis.

As an addition to data from which a more complete knowledge of certain celestial phenomena now unexplained may in future be derived, it may not be out of place to record a description of a peculiar and interesting phenomenon seen by the writer and others at sea off the coast of Newfoundland.

On September 12th, 1881, after a nine days' voyage on the *Atlantic* from London towards Halifax, N. S., Cape Race was sighted about noon. Our course after noon was about southwest; at eight o'clock in the evening (ship's time) our position — estimated roughly by the course and speed of the ship — was Lat. 46° N., Long. 55° W. The sky was partly clear in the north and west and overhead, but hazy and in places cloudy in the south and east. The aurora was clearly to be seen in the northern sky, sometimes shooting up streamers of light nearly to the zenith, and varying continually in form and brightness; this display, however, was no more brilliant or interesting than many similar ones seen on other nights, and deserves mention only to be distinguished from the following. But in the southeast sky, about 30 or 35 degs. above the horizon, there appeared two horizontal streaks of light—about 5 degs. apart and 15 or 20 degs. in length—which at the time I took to be two clouds highly charged with electricity. The accompanying sketch (Fig. 1) will be of service in describing the appearance, but must not be taken as accurate in any detail, being made after some months and from memory; moreover, the entire phenomenon was continually changing. Both streaks were luminous, with a pale hazy light very similar to moonlight. From the upper of the two were suspended by small cords of light a number of balls, brighter than either of the streaks, which were continually jumping up and down in vertical lines, much after the manner of pith-balls when charged with electricity. Above the upper streak there was a bright space, whose sides were convergent at about the angle shown in the sketch, which seemed to be composed of streamers of light, gauzy in appearance and decreasing in brightness from the streak outwards. From the lower streak a similar mass of light extended. The only difference noticed in the two streams of light was that the inclination of the lower was greater than that of the upper.

(Fig. No. 1.)



I appeared on the scene about fifteen or twenty minutes after the beginning when the brilliancy of the display was approaching a maximum. Soon after it began to fade, the balls and cords first gradually disappearing, then the streamers of light on both sides, and finally the two horizontal streaks—the whole being lost to sight in the darkness in the course of about fifteen minutes.

When first seen the phenomenon had the appearance shown in the sketch (Fig. 2), kindly furnished me by Prof. Halsey C. Ives, who had the good fortune to see the display at the beginning, but lost the latter part of it. The sketch gives an idea of what he saw only in general form. He says that it did not seem to him that there were clouds, but rather a space between clouds through which light was streaming: the upper luminous appearance seemed to him to be an inverted reflection of the lower one. The position remained unchanged during the whole time.

No explanation of the phenomenon is offered.

The matter may have a wider interest when it is remembered that on the evening of September 12th, at the same hour, a most remarkable band of white light was seen at Albany, N. Y., Utica, N. Y., Hanover, N. H., Boston, Mass., and elsewhere in the North Atlantic States, spanning the heavens from east to west near the zenith. The following account of the phenomenon seen at Albany, given by an assistant at the Observatory, is taken from the Albany *Argus:*

(Fig. No. 2.)

"At eight o'clock I first saw it, and its effect was absolutely startling. It spanned the heavens from east to west, and seemed of very nearly equal breadth the whole distance. It was sharply defined. At its southern edge it extended from the horizon through Zeta and Delta Bootis; thence through Nu Pi Hercules, to and through Alpha Lyra. From that point it extended to the south of the Great Square in Pegasus. The northern branch in the east extended up through the head of Draco, and there seemed to be a strong ray of light, very marked, continuing from Gamma Bootis, while around to the north there were several parallel streaks inclined at an angle of fifty degrees with the general motion of the phenomenon. Three or four of these were noticed near the head of Draco. At 8:30 it was observed to clear away on the zenith. The eastern portion now consisted of a narrow strip, very bright clearly marked at the edges, extending from Gamma Pisces through Alpha Lyra, and at the same time seeming to be moving southwest, it being about thirty degrees from the zenith and appearing to roll like columns of smoke spirally towards the west. At 8:33, in the east were two parallel streaks, the northern the heavier and the southern throwing out diverging lines of light that seemed to gradually curve as they approached the zenith. At 8:35 o'clock the main branches had separated at the zenith, while the western one was very narrow, extending through the Northern Crown. A small line of light now extended from a point about three degrees north of Alpha Lyra to a point about seven degrees from Eta Ursa Majoris. At 8:39 a brighter streak appeared between Alpha Lyra and Ursa Majoris, while that over the Crown was broken up into a series of parallel, smaller and fainter streaks. The eastern branch was now very faint and narrow, and extended nearly from Pi Pisces to Alpha Lyra, while all along the northern horizon was a bright rosy glow like the northern lights, but brightest toward the west. At 8:45 the phenomenon presented a faint, yet beautiful appearance, and at 8:55 it had vanished."

In the Kansas City *Review of Science and Industry*, November, 1881, Prof. S. A. Maxwell, Morrisonville, Ills., remarks:

"The mysterious band of light seen at Albany was probably, what I have stated, a mere auroral arch, but, appearing as it did in the zenith, more nearly resembled a band than an arch. The same viewed from a lower latitude would have presented an arch-like appearance, similar to those often seen by us in the distant north; and these latter would present to an observer beneath them the same band-like appearance seen at Albany."

My point of observation was north and east of any I have seen mentioned; some other explanation is needed for the appearance there presented.

The Planets


The Signs of the Zodiac
Planetary Configurations
I
II
III
IV
V
VI
VII
VIII
IX
X
XI

Planetary Configurations on Cyprian Antiquities.

By Prof. Gust. Seyffarth, Phil. & Th. D.

It is notorious that Gen. L. P. di Cesnola, having served the United States during the civil war, and being a few days prior to President Lincoln's assassination in 1865, appointed American Consul for Cyprus, discovered a great many Assyrian, Phœnician, Persian, Egyptian, Cyprian, Greek, and Roman antiquities in that island. He made excavations in eight different cities and fifteen temples with such good effect that 35,573 objects came to light. His work, "Cyprus," New York, 1878, specifies the following objects:

Assyrian inscriptions on cylinders	4
Phœnician " "	30
Cypriote " "	62
Greek " "	105
Coins, gold, silver, and copper	2.310
Vases	14.240
Statues	2,110
Busts and Heads	4.200
Cippi and Stelæ	138
Bas-reliefs	270
Sarcophagi, sculptured	4
Gems, Cylinders, and Scarabæi	3.719
Serpentine Stone, Hæmatite, Egyptian enamelled ware	472
Objects in gold	1.599
Objects in silver	370
Objects in copper and bronze	2,107
Objects in alabaster and rock-crystal	146
Objects in ivory, bone, lead, and iron	217
Terracotta Lamps	2.380
Total	35.573

Of these precious relics 5,000 were lost at sea in 1871, others were presented to the Ottoman Government, to the Ottoman Museum at Constantinople, to the R. Museums at Munich and Turin, to the Anthropological Museum at Turin, to the Archæological Society at Athens, to the Museum at Perugia, to the Smithsonian Institution, to the British Museum, and to the Museums of Petersburg, Berlin, Cambridge, Kensington, and Boston. The rest of Cesnola's collection, about 20,000 objects, have been purchased by a number of patriotic citizens of New York city, of whom Mr. John Taylor Johnston contributed the principal share of the requisite sum, $130,000.

All these antiquities will be found in "The Metropolitan Museum of Art," a new grandiose building in our Central Park, as soon as the former shall be opened to the public next spring.

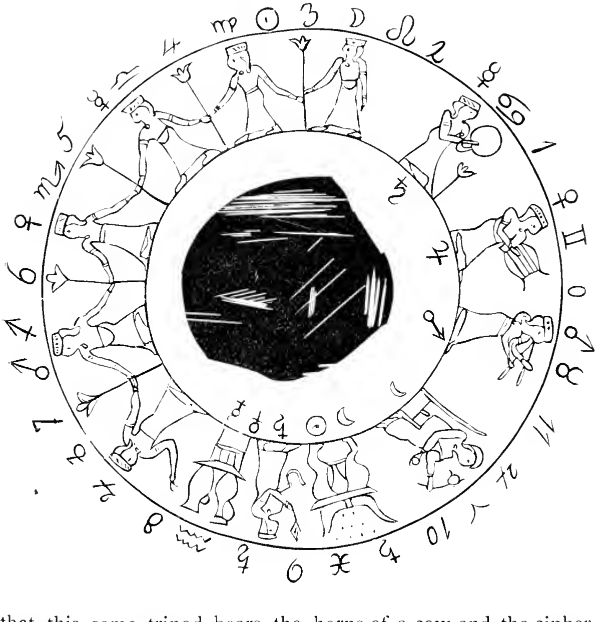
The most important Cyprian monuments, apart from the Egyptian, Phœnician, Assyrian, Greek, Roman, and proper Cypriote inscriptions, are, no doubt, the astronomical ones, because they fix the dates of certain events of history with mathematical certainty, and confirm the ancient reports that all nations of antiquity worshipped the same deities, viz., the seven planets and the twelve signs of the Zodiac; and that all religions of old originated from one source in Asia, as has been demonstrated in these Transactions, vol. iv., No. 1.

Cesnola's work represents four astronomical inscriptions discovered in Cyprus (pp. 114, 276, 329, and 77), expressed upon silver, bronze, and copper bowls. The latter inscription being the most instructive, we shall confine ourselves to the interpretation of that only.

The appended cut is a reduced copy of Cesnola's *fac simile* of the said bronze bowl, 5½ inches in diameter, 2½ inches high, discovered in a tomb at Dali, the ancient Idalium, to which we added the corresponding primitive signs of the Zodiac and their respective planetary wardens, as will be seen hereafter.

These singular images have been, as far as possible, explained by Ceccaldi in Revue Archéolog. 1872, vol. xxiv., p. 24, as follows. He takes the six figures with joined hands for dancers, and the sitting figure in ♌ No. 10 for Isis. Hence he continues (p. 78 in Cesnola's work) as follows: "It is therefore probable that the goddess here represented (in ♈) was one the performance of whose rites and ceremonies devolved upon women. Cyprus enjoyed a high reputation from very early times for musical skill both with the flute and the lyre, and there can be little doubt that this skill has been attained and developed chiefly through religious practice such as that illustrated on this bowl. The vases represented on a table (♒) in front of the dancers are ornamented with designs peculiar to the very archaic pottery found at Idalium and elsewhere, not only in Cyprus, but in other Greek islands, and in the mainland of Greece and Italy. The bronze bowl may therefore be taken to be contemporary with this form of decoration in pottery."

I do not know whether this explanation of the bowl will satisfy every reader; for each one will ask the questions: How is it that the presumed Isis bears the crescent upon her head? What has the tripod of Apollo to do with the Cyprian dancers? How is it



that this same tripod bears the horns of a cow and the cipher III III III (9)? What signify the six virgins with joined hands? For what purpose are the latter intertwined with lotus-flowers? As seven figures turn towards the right hand, what is the reason that three other figures walk in the opposite direction? What is the meaning of the serpent, the pine, the solar disk, the flute, the lyre, the tambourine in the hands of some women?—None of these questions can be answered except by the writer's *Astronomia Ægyptiaca*, Leips. 1833.

The key to the astronomical monuments of the Egyptians, Greeks, Romans, Cyprians, etc., so often mentioned and referred to times immemorial by ancient authors, was discovered in 1827. During my annual studies, extending throughout one year, in the R. Museum of Turin, I resolved, at last, to re-examine a large box containing half a million of papyrus fragments which had been examined two years earlier by Champollion. Among these fragments a small papyrus, representing the Zodiac and a planetary configuration, was found, of which a *fac simile* will be seen in the aforesaid Astronomia Æg. Tab. iii. This papyrus brought to light—

1. That the deities of the Egyptians and all other nations of antiquity were the seven planets and the twelve signs of the Zodiac.

2. That the ancients expressed the planets and the signs by the images of their gods, specified by ancient authors.

3. That a certain planet or sign was very often signified by the figure of an animal, or plant, or other object, which the ancients referred to the "*Ducatus*" of the same planet or zodiacal god.

4. That the retrograding planets were expressed by retrograding deities or animals; thus the papyrus under consideration represents the vulture (♄) and the sparrow-hawk (♀) looking backward.

5. That in case two planets or more appeared in the same sign, but in different Decuriæ of the same sign, commonly one of them was transferred to another sign, viz., that which belonged to the same planetary warden who presided over the said Decuriæ.

6. That the ancients recorded the places of the seven planets on a cardinal day, mostly on the day of the winter solstice.

This key to all kinds of ancient astronomical inscriptions has been discussed *in extenso* in the author's Astronomia Æg., and confirmed by a great number of other astronomical monuments. Our Turin papyrus refers to 128 B.C., Dec. 23, as the following comparison of the observation with the computation, though superficial, demonstrates:

OBSERVATION.		COMPUTATION.	
☉	$9^s\ 0^\circ$	☉	$9^s\ 0^\circ$
☽	$10^s + ^\circ$	☽	$10^s\ 15^\circ$

♄	$9^s + ^\circ$ retrograding		♄	9^s	26° retrograding
♃	$8^s + ^\circ$		♃	8^s	11°
♂	$10^s + ^\circ$		♂	10^s	14°
♀	$9^s + ^\circ$ retrograding		♀	9^s	21° retrograding
☿	$8^s + ^\circ$ near the sun		☿	8^s	17° near the sun

The objection that the Greeks and Romans would not have observed planetary configurations in the manner of the barbarous Egyptians is removed by the fact that, e.g., the following classic monuments contain astronomical observations, expressed in the same way. See the author's "Berichtigungen der alten Geschichte," etc., Leips., 1855, p. 28.

The Olympian Altars	777	B.C.	March	29
Rome's Nativity	752	"	May	25
Jupiter Olympius	489	"	Sept.	25
Parthenon Frieze	479	"	March	26
Lectisternium, Livy v. 13	396	"	Dec.	26
" " xxii. 10	216	"	"	24
Ara Albani	62	"	Oct.	27
Puteolian Basis	39	"	Dec.	23
Puzzuoli Sarcophagus	26	"	"	23
Pompejian Wall	22	"	March	24
Capitolian Puteale	9	"	Dec.	23
Borghesian Ara	7	"	March	22
Gabinian Ara	9	A. C.	"	23

And so on down to 131, 137, 138, 255 A.D.

We are now ready to proceed to the analysis of quite a new class of astronomical monuments represented by the bronze bowl of Cyprus.

1. *The signs of the Zodiac.*

The first question is: What signify those eleven female persons of which ten bear garlands of ivy round their heads? These virgins being very decently vested, it is obvious they cannot be priestesses of Venus Paphia, as was surmised. From the following ancient reports we shall learn that the Muses were originally the signs of the Zodiac; in the second instance, the corresponding months of the solar year; and finally, the arts and sciences cultivated during the more pleasant nine months of the year.

The ancients bear witness that the Muses were represented with garlands of ivy or laurel, as our Cyprian bowl shows.

Pausanias (v. 18, 1) reports that on the chest of Kypselos the Muses were expressed by dancing virgins, each linking hands with the neighboring two, as our Cyprian monument evidences.

Mount Helicon is notoriously the emblem of the elevated mount of the starred heavens, and this Helicon was the dwelling of the Muses as well as of the planetary and zodiacal deities: there the Muses delighted the gods by songs, whilst Apollo, their leader, i.e. the house of the sun, played the phorminx.

The same residents of the star-covered Olympus continually danced around the altar of the Kronion, i.e. the earth, because the signs of the Zodiac revolve around our globe every day. Hence the Muses were, as the ancients bear witness, very often depicted with wings.—Hesiod, Theog. 1.

The Muses were acquainted with the past, the present, and the future; and these faculties concern only the signs of the Zodiac, because the ancients predicted the fate of a human being by means of the Zodiac and the planets, observed on the birth of the respective individual.

Pausanias (ix. 30, 1) narrates that in mounting Helicon the traveler first encountered the temple of the three Muses; after a while that of three other Muses; then that of the seventh, eighth and ninth Muses. On the top of the mountain (Olympus nivosus) finally stood the temple of three other but different Muses, viz., the three Charities, the "sisters of the Muses."—Hesiod, Theog. 64.

All these reports concur in demonstrating that the Muses, as regards their principal meaning, refer to the signs of the Zodiac. However, it will be objected that Homer (Od. 24, 60), Hesiod (Theog. 77), Servius, and other authorities, mention only nine Muses, and that no ancient author counts twelve. This stumbling-block is removed by the explicit ancient testimony that the proper Muses commenced singing at the beginning of spring—"*nam verno tempore nives tabescunt.*" Hence it is apparent that the proper nine Muses signified the actual signs Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, and Sagittarius; whilst the improper Pierides, the "sisters of the Muses, the Charites, referred to Capricornus, Aquarius, and Pisces, the top of the *Olympus nivosus*.

Moreover, Hesiod (Theog. 64) asserts that the 9 Muses and the 3 Gratiæ dwelt together, and danced together, and sang together; therefore both classes of deities must have belonged to the Zodiac, the 9 Muses and the 3 Gratiæ completing the 12 signs. Thus it is put beyond question that the crowned virgins on the Cyprian bowl represented the signs of the Zodiac.

Besides, the fact makes no difference that in earlier times the spring commenced with Gemini, the house of Venus, in consequence of the precession of the fixed stars. Furthermore, the spectator will notice that in nearly all cases a lotus-flower is inserted between two Muses, and, since this plant grows only in water, it argues that the Musæ belonged to the heavenly blue ocean and not to terrestrial domicils.

Finally, even the names and insignia of the Muses aver that the latter have from the beginning symbolized the signs of the Zodiac.

Referring the Muses, according to their order handed down by Hesiod, to the Zodiac and its planetary wardens, we obtain the following scheme:

♍ ♀ 6.	♎ ☿ 5.	*np* ☉ 4.	♌ ☽ 3.	♋ ☿ 2.	♊ ♀ 1.
Terpsichore.	Melpomene.	Thalia.	Euterpe.	Clio.	Calliope.
♉ ♄ 12. ♈ ♃ 11. ♓ ♄ 10.		♒ ♄ 9.	♑ ♃ 8.		♐ ♄ 7.
The 3 Gratiæ.		Urania.	Polyhymnia.		Erato.

1. Since Gemini, the house of Venus, constituted the primitive first sign of the Zodiac, commencing with the primitive point of the vernal equinox, Calliope, the first of the Muses, must of course be referred to Gemini. Now Calliope, acccording to the root ὀπ-, ὄψις, signifies the beautiful looking, and this is the universal appellation of Venus, the planet from which *Venusius* (*pulcher*) originated.

2. Clio (from the root *κλε-*, *κλέος*, *inclytus*, to make notorious, celebrate), holding a papyrus scroll, typifies the house of Mercury, because this god invented and cultivated the same arts and sciences that belonged to Clio, e.g. writing books, memorials, epics, etc.

3. Euterpe, the charming one, obviously symbolized the moon, so much delighting ancient as well as modern people.

4. Thalia, r. *θάλλω* (procreating, verdant and blooming), is the natural name of the sun, the procreating power of the vegetable kingdom. Hence Thalia's distinctive symbol was the shepherd's crook (*pedum*), the usual designation of the sun-god in Egypt; otherwise, what had the Muse of cosmic poetry to do with the emblem of shepherds?

5. Melpomene, r. μέλπομαι (amusing with playing, singing, dancing), points us to Mercury, the warden of Libra, because the *musici*, *citharœdæ*, and the like, belonged to the ducatus of Mercury.—Astron. Æg. p. 104. But I do not see why tragic poetry was transferred to Mercury; at least τράγος, the buck, was Mercury's animal (Astron. Æg. p. 110).

6. Terpsichore, i.e. diverting by dances, clearly signifies Venus, the œcodespota of Scorpio, because all *Cauponia* belonged to the same deity (Astron. Æg. p. 196).

7. Erato, being derived from ἐράω, signifies the Muse of erotic songs; and to Mars, the warden of Sagittarius, the ancients ascribed *omnis generis procreationem et vivicationem.* Hence Mars was also called Phtha Socharis (שגל shagal), Mars generator. I do no not know whether Ἄρτες and Ἔρτωσι (ep-τωxι. generator), the surnames of Mars (Astron. Æg. 101) involve the name of Erato.

8. Polyhymnia, i.e. abundant of hymns, or by Lucian (5th Pt., 145) being called πολύμνεια, the much celebrated one, denotes perhaps Jupiter, the œcodespota of Capricornus, owing to this planet being, next to the sun, the most celebrated god of the ancient nations.

9. Urania, i.e. *cœlestis*, the Muse of astronomy, certainly belongs to Aquarius, the house of Saturn, because the ocean, particularly the heavenly ocean, belonged to the ducatus of Saturn, as even the monogram of Aquarius (♒) corroborates. Urania is the Egyptian Nepthys, "*Venus Urania*" (na-τqϕn or nn ϕn).

Now, recollecting that the 9 Muses and the 3 Gratiæ corresponded to the 12 signs of the Zodiac; that both dwelt together in the same heavenly firmament; that both revolved around our globe singing and dancing; that especially the 9 Muses represented the 9 signs of the Zodiac from the vernal equinox to the winter solstice; that the Muses were represented with joined hands and bearing garlands on their heads, as our bowl shows; that the same knew the past, the present, and the future, which faculties the ancients appropriated to the zodiacal signs; that even the names and insignia of the Muses agreed with the predicates of the zodiacal gods,—nobody will gainsay that the virgins on our Cyprian antique express the segments of the Zodiac.

We come now to the solution of another essential question, namely, the following:

2. *What Planets were signified by the other Figures?*

Every one notices that eight Muses in ♒, ♓, ♈, ♉, ♊, and ♋, are distinguished by certain insignia, the meanings of which are determined by the ancients themselves.

First, the tripod of Apollo explains itself; for Apollo is the well known sun-god. The imposed horns of a cow point to the moon, because the cow, like the cow of Io (ιορ, the moon), was the emblem of the moon (Astron. Æg. p. 153). The cipher nine indicates that the longitude of the sun was nine signs, and, since the latter commenced always with the vernal equinox, it is apparent that the Cyprian planetary configuration was, as usual, observed on the day of the winter solstice (♓ 0°). Thus the consecution of the zodiacal signs is fixed; their order was that exhibited on cut (p. 397).

Next to the tripod, the house of ♃, we notice in ♈ a woman bearing the crescent upon her head, and therefore the moon stood on that day near the sun, in a department of ♃.

Further, behind the tripod we see in ♒ a muse bearing a serpent and a cedar-tree in her hands, both belonging to the ducatus of Saturn (Astron. Æg. p. 166, 172); consequently Saturn stood on the same day in Aquarius, near the sun.

In the same section of the Zodiac two vases posted upon an altar appear, which must of necessity represent Venus and Mercury in Aquarius, because both planets constantly accompany the sun. That elegant ansated vase, obviously made of metal, must signify Venus, because the metal tin belonged to the ducatus of Venus (Astron. Æg. p. 184).

This disposition of the sun in ♓ 0°, of ♄ and ♀ and ☿ in ♒, of ☽ near the ☉, is sufficient to determine the year in which the Cyprian planetary configuration had been observed; for since, on the same day of the year, ♄ returns first after 30 years, the ☽ first after 19 years, ♀ first after 8, ☿ first after 13 years to the same place; the same planetary configuration returns first after 30×19×13×8, i.e. after 59,280 years; and our planetary Tables state that the said planets occupied the mentioned places in −397. Dec. 25, as we shall see further on.

Let us now inquire whether this result is confirmed or refuted by the places of the other planets.

Behind the Moon in ♈ we notice three deities retrograding towards the Sun, and such figures, as we have seen, constantly declared retrograding planets, which was in –397, Dec. 25, the case with Mars, Jupiter, and Saturn, as the computation will substantiate.

The figure behind the Moon, retrograding in ♉, is Mars; for this Muse plays on the double-flute, the instrument of Mars (Astr. Æg. p. 180). The same instrument, therefore, was used at the feasts of Minerva, the female Mars (Berich. d. a. Gesch. p. 205).

After Mars another Muse, playing on the lyre, is represented retrograding in ♊, obviously ♃, because he is the only planet not yet mentioned on our bowl. Horapollo (ii. 116) testifies that the lyre signified συνόχεα καὶ ἑνωτικόν, and the mythographers relate that Mercury, the author of the lyre, delivered it to Apollo, commonly signifying the Sun. Since, however, the Sun and Jupiter were considered identical, for which reason Osiris sometimes signifies the Sun, sometimes Jupiter, it is probable that for this reason the planet Jupiter was symbolized by the lyre.

In addition, it will be necessary to obviate some difficulties. First, since after Jupiter another planet appears retrograding in ♋, it will be objected that the Cyprian bowl properly mentions eight planets. But it is to be borne in mind that in case two planets occupied the same sign, one of them was referred to another, viz., that whose warden was the same planet which presided over the decuria occupied by the said planet. This was the case with Saturn, who appeared with ♀ and ☿ in ♒, but in the Horion of Mercury (17°–21° in ♒), and therefore ♄ was again mentioned in ♋, the house of Mercury. (See the writer's Astron. Æg. Tab. I.) We do not know, besides, for what reason the Cypriotes referred the tambourine to Saturn.

Further, it is strange that the image of the Moon looks toward the Sun like the retrograding planets Mars, Jupiter, and Saturn; and, as we shall see directly, that the Moon is referred to ♈, while she, according to our Lunar Tables, stood in ♓, near the Sun. These seeming incongruities, however, are easily overcome. The Moon's place in ♓, the house of ♄, is clearly indicated by the cow-horns. The lotus, ♄'s emblem, as we have seen, and the solar disk in the hands of the Moon, indicates that the latter occupied the Decuria of the ☉ in the house of ♓(♄), no solar Decuria existing in Aries. In short, the Moon is put out of ♓ and transferred to ♈, simply because there was no better place for signifying her conjunction with the Sun in ♓. The Moon's figure, seated upon a throne, is not *retrograding*, but *retrospective* to the Sun, because she belonged to the sign entered by the Sun. Besides, seven hours later the Moon stood both in ♓ and ♈ ($9^s\ 30^\circ = 10^s\ 0^\circ$).

Computation of the date –397, *Dec.* 25, ☉♄ P. T.

	ANCIENT OBSERVATION.	TABLE RESULTS.
☉	$9^s\ 0^\circ$	$9^s\ 0^\circ$
☽	$9^s\ 20^\circ–30^\circ$	$9^s\ 26^\circ$
♄	$8^s\ 17^\circ–21^\circ$ retrograde	$8^s\ 18^\circ$ retrograde
♃	$0^s\ +^\circ$ retrograde	$0^s\ 10^\circ$ retrograde
♂	$11^s\ +^\circ$ retrograde	$11^s\ 4^\circ$ retrograde
♀	$8^s\ +^\circ$ (near the sun)	$9^s\ 0^\circ$ (near the sun)
☿	$8^s\ +^\circ$	$8^s\ 6^\circ$

This calculation, though superficial, is sufficient to fix the date of the observation with mathematical certainty. No similar planetary configurations happen during a period of 2,146 years, in which Saturn performs 74 revolutions, Jupiter 170, Mars 67 of 32 years each, Venus 268 of 8 years, and Mercury 168 of 13 years each.

CONCLUSION.

The discovery of our Cyprian antiquities is, in many respects, of interest; for,

1. The original mirrors, the arts and sciences of the inhabitants of an island known since Gen. x. 14, and repeatedly mentioned in history since Homer, as the principal work, "Engel's Cyprus," specifies. By the way, it is an error of Gesenius to refer the primitive name of Cyprus, viz., כַּפְתּוֹר (Kaphthor), not to Cyprus, but to Creta, for the Tanis-stone translates Capththor by Cyprus.—In 397 B.C. the Greek population must have been numerous in Cyrus; the arts, sciences, and religious ideas of the Greeks still prevailed in that island. In the same year Socrates died in Athens; Plato, 28 years old, went over to Megaræ; the Lacedæmonians warred a second time against the Elians; the tribunus militum P. Manlius Vulso ruled in Rome. In the pre-

ceding year Cyrus was killed by his brother Artaxerxes Mnemon, and the 10,000 Greeks returned from Persia. — Is it not interesting that a contemporaneous memorial has been preserved down to this day?

2. The Cyprian bowl confirms the testimonials of Aristotle, Chæremon, Tacitus, Plutarch, Lutatius, Cicero (see these Transactions vol. iv. p. —), that the deities of all ancient nations were the same, to-wit, the seven planets and the twelve signs of the Zodiac, and not at all "geographical phenomena of Greece and Italy. The natives of Italy and Greece differed very much from those of Cyprus, and yet the inhabitants of the latter possessed the same divinities worshipped in Italy, Greece, Egypt, Phœnicia, and Assyria, as the other Cyprian antiquities in Cesnola's collec-lection evidence. The coincidence of the Cyprian deities with those of so different nations strengthens Jeremiah's and the Georgian chronicle's testimony that all pagan religions originated in Babylonia prior to the dispersion of the primitive nations.— Moreover, the same bronze bowl throws unexpected light upon one of the most obscure chapters of Greek and Roman mythology: we know now what the nine Muses and the three Graces properly represented, and it is to be regretted that the same deities were totally misunderstood in the valuable "Realencyclopædie" published by Pauly, Stuttgard, 1848.

3. Finally, the aforesaid four planetary configurations on Cyprian antiquities show how much of astronomy and astrology were divulged on our globe in ancient times. A great number of such inscriptions, originating in Egypt, Greece and Italy, are known since 1833. To these the Cyprian ones are now to be added. Further, in the British Museum a number of Persian monuments will be found on which similar planetary configurations, likewise represented, will be noticed. The "Golden Horn of Copenhagen," the so-called Cluobdas, the Eddas, etc., demonstrate that this science was likewise cultivated in ancient Germany, Denmark, Norway, etc. (See "Bericht vom J. 1833 an die Mitglieder der Deutschen Gesellschaft zur Erforschang vaterländischer Aetherthuemer.") In the Zendavesta of the Parsees and the Vedas of the East Indians a number of similar planetary configurations have been preserved. (See the writer's "Chronologia Sac." 1846. The same astrology has been practised in East India

down to this day, and I myself have seen the nativity of a converted Tamulian, written some years ago. The Chinese astrologers are known, but it is a new and remarkable accession that Kingsborough's Mexican and the American antiquities discovered near Davenport, Iowa, represent similar planetary configurations, as will be demonstrated in another place.

These certainties that in all quarters of our globe planetary constellations have been observed and expressed quite in the same way, and that many of them incontrovertibly concern the year 2780 and even 3446 B.C., constrain us to believe that ancient astronomy must have proceeded from a primitive nation in Asia, as Cicero and the Georgian Chronicle in Journ. Asiat., Paris, 1833, p. 535, state. The Greek astronomical papyrus commented on in the author's Astronomy, p. 212, assigns this science to the primitive savans of Chaldæa, and this is ascertained by the fact that our actual constellations exactly agree with those of the ancient Chaldeans and Egyptians.

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*On a Property of the Isentropic Curve for a Perfect Gas as drawn upon the Thermodynamic Surface of Pressure, Volume, and Temperature.**

By FRANCIS E. NIPHER.

The equation of this thermodynamic surface is

$$pv = RT, \quad . \quad . \quad . \quad . \quad (1)$$

where p, v, T represent the pressure, volume, and absolute temperature, and where R is directly proportional to the volume of a unit mass (or inversely proportional to the density) of the gas at a standard temperature and pressure.

By differentiation (1) becomes

$$dp = \frac{R}{v} dT - \frac{RT}{v^2} dv \; . \; . \quad . \quad . \quad (2)$$

For convenience putting

$$\frac{R}{v} = A \quad , \quad \frac{RT}{v^2} = B \, ,$$

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* Read April 3, 1882.

and (2) becomes

$$dp = AdT - Bdv. \qquad (3)$$

1°. To find the direction of maximum slope with respect to the $v\ T$ plane at any point on the surface. For this purpose pass a plane through any point in the surface, and at right angles to the vT plane. Its trace upon the vT plane is

$$T = \beta + av, \quad . \quad . \quad . \quad (4)$$

p being indeterminate; where a is the tangent of the angle which the trace makes with the v axis, or

$$a = \frac{dT}{dv}. \quad . \quad . \quad . \quad . \quad (5)$$

From (3) and (5) we have

$$dp = (Aa - B)\ dv. \quad . \quad . \quad . \quad (6)$$

Calling S the slope of any element of the intersection of the plane and the surface, dz being the projection of the element on the $v\ T$ plane, we have

$$S = \frac{dp}{dz} = \frac{dp}{\sqrt{dv^2 + dT^2}}, \quad . \quad . \quad (7)$$

which by (5) becomes

$$S = \frac{dp}{dv} \cdot \frac{1}{\sqrt{1 + a^2}},$$

and by (6) we have further

$$S = \frac{Aa - B}{\sqrt{1 + a^2}}. \quad . \quad . \quad . \quad (8)$$

In determining the direction of maximum slope at any point, it is evident that A and B will be constant, which gives as the required condition,

$$\frac{dS}{da} = \frac{A + Ba}{(1+a)^{\frac{3}{2}}} = 0,$$

or

$$a = -\frac{A}{B}.$$

Substituting the values of A and B, we have

$$a = -\frac{v}{T} = -\frac{R}{p} = \tan i \quad . \quad . \quad . \quad (9)$$

For very low pressures, the direction of maximum slope $\frac{dp}{dz}$ becomes more and more nearly at right angles to the plane of p, v; while for high pressures this direction becomes more and more nearly parallel to the plane of p, v. The direction of maximum slope is constant along a line of constant pressure.

2°. To find the direction of the isentropic line at any point on the surface, as related to the direction of maximum slope determined in (9).

Poisson's equation:

$$T v^{k-1} = \text{const.} \quad . \quad . \quad . \quad (10)$$

is a projection of the isentropic line upon the plane of v T. k being the ratio of the specific heats $= 1.41$.

Calling a' the tangent of the angle which any element of this projection makes with the v axis, we have

$$a' = \frac{dT}{dv} = \tan i'.$$

This value of a' is obtained by differentiating (10) and is found to be

$$\frac{dT}{dv} = -\frac{T}{v}(k-1) = -\frac{P}{R}(k-1) \quad . \quad . \quad (11)$$

Here also the condition of constant pressure gives a constant value for a'. Hence, at any point along any line of constant pressure the projection of an element of the isentropic line, upon the v, T plane, makes a constant angle with the projected line of greatest slope at the same point.

From equations (9) and (11) it follows that

$$\tan i' = \frac{k-1}{\tan i}; \quad . \quad . \quad . \quad . \quad (12)$$

from which it will appear that for either very high or very low pressure the isentropic line runs at right angles to the direction of greatest slope. The condition that it shall coincide with the direction of greatest slope is

$$\tan i' = \sqrt{k-1} = \frac{R}{p},$$

or

$$p' = \frac{R}{\sqrt{k-1}}. \qquad . \quad . \quad . \quad (13)$$

For air this pressure is about $3._2$ millimeters of mercury, and for other gases it is proportional to the volumes of a unit mass, at a standard temperature and pressure.

The thermodynamic surfaces of various gases will lie the one above the other, those having the largest value of R being uppermost. If we now substitute the value of p' of (13) in the original equation of the surface, we have

$$v = \sqrt{k-1}\ T, \qquad . \quad . \quad . \quad (14)$$

which is independent of R. Hence, for all gases which follow the law represented in (1) the lines on their respective surfaces where the isentropic lines coincide with the direction of maximum slope (13), will all lie in a common plane passing through the axis of P and at right angles to the plane of v T, its trace upon the latter plane being represented by (14).

If the gases have a common temperature while in this condition, (14) shows that they will also have a common density, which when T is 273° will be $0._{0000058}$ grammes to the cubic centimeter.

It will be observed that for air, the pressure indicated in (13) is practically the same as that at which Maxwell's law for viscosity begins to fail. This, however, is a mere coincidence, as the two phenomena have nothing in common, as is evident both from theoretical considerations and from experimental results.

Washington University, March 30, 1882.

The original Egyptian names of the Planets, according to a Turin papyrus, and some new Planetary Configurations.

By Prof. GUST. SEYFFARTH, Phil. & Theol. D.

The question how the Egyptians called and represented their seven planets—Saturn (♄), Jupiter (♃), Mars (♂), the Sun (☉), Venus (♀), Mercury (☿), the Moon (☽)—as they were commonly enumerated according to their apparent velocities, interests not only all professed Egyptologists and astronomers, but in general every friend of science. It involves the key to the astronomical monuments of the Egyptians, Greeks, Romans, etc., and the emendation of the whole of the usual ancient chronology.

First, all ancient classic astronomers report that the 12 signs of the Zodiac passed for the houses of the planets, and hence the names and emblems of the zodiacal segments depend on the names and emblems of the planets.

Further, Jamblicus, apart from other authorities, bears witness to the fact that the ancient Egyptians worshipped only two classes of higher deities—the seven planets, called Cabiri, i.e. the mighty ones, and the 12 signs of the Zodiac, the so-called 12 great gods. The passage is to be seen in vol. i. p. 358, of these Transactions. The same we read in Apollonius Rhodus, v. 262: *Αἰγύπτιοι—τὰ δώδεκα ζώδια θεούς βουλαίους προσαγορεύσιν, τοὺς δὲ πλανήτας ῥαβδοφόρους.* Accordingly, the names and emblems of the planets will inform us what the numberless mythological images occurring on Egyptian monuments and papyrus-scrolls refer to.

Besides, Plutarch (De Is. p. 377), Aristotle (Met. xi. 8), Cicero (N. D. i. 30, "*quot hominum linguæ, tot nomina deorum*," and N. D. i. 10), Seneca (iv. 7, 8), Porphyrius (De Abst. iv. 9), Jeremiah (li. 7; x. 2), unanimously testify (see their words in these Transactions, vol. i. p. 357, 381) that all nations of old worshipped the same deities, namely, the seven planets, to which sometimes the god of the Earth was added, and the 12 constellations of the Zodiac. Consequently the Egyptian deities must bring to light what all other pagan deities, particularly those mentioned in the Old and New Testaments, properly signified. *Vice versa*, sometimes the Greeks and Romans explain Egyptian deities by paralleling them with their own already known gods and goddesses.

Add to this what history reports concerning the multitude of astronomical inscriptions preserved in Egypt, and their antiquity. Diodorus of Sicily (i. 81, 83) narrates that Egyptians have, times immemorial since, preserved innumerable astronomical observations (τὰς περὶ ἑκάστων ἀστρῶν ἀναγραφάς, ἐξ ἐτῶν ἀπίστων τῷ πλήθει φυλάττουσι). Simplicius (p. 27) testifies that the same preserved astronomical observations 2,000 years old. In Cicero's Divinatio we read the following: *Principio Assyrii—trajectiones motusque stellarum observarunt, quibus notatis, quid cuique significaretur memoriæ prodiderunt.—Eandem artem Ægyptii longinquitate temporum* INNUMERABILIBUS *pæne sæculis consecuti putantur.* The same is confirmed by Aristotle (De Cœlo, ii. 12). Indeed a great many of such Egyptian monuments have been published already in the "Description de l'Égypte," Rosellini's "Monumenti del' Egitto e della Nubia," Burton's "Excerpta hieroglyphica," Champollion's "Monuments de l'Égypte," Lepsius's "Ægyptische Denkmaeler," and the like. Besides, nearly all Egyptian museums in Europe and America preserve similar antiquities, going back from Constantine to Menes. And all these numberless very old relics of Egyptian wisdom would remain inexplicable forever, or at least doubtful, had Providence not preserved a papyrus-scroll on which the elements of Egyptian astronomy are clearly and reliably recorded.

Finally, it is universally known that the history of Egypt, from the fathers of the Church down to this day, has been a very chaos. Since 1839 more than 30 Egyptian chronologies have emerged, none of which refers the beginning of the kingdom of the Pharaohs to the same year; e.g. they refer Menes to –6467 (Henne), 5867 (Champollion), 5773 (Lesueur), 5702 (Boeckh), 5652 (Hekekyan Bey), 5613 (Unger), 5303 (Henry), 4915 (Lenormant), 4890 (Baruchi), 5455 (Brugsch), 4400 (Pickering), 4175 (Louth), 3895 (Hincks), 3892 (Lepsius), 3623 (Bunsen), 3187 (Mayer), 2785 (C. Gumbach), 2781 (Uhlemann), 2717 (Poole), 2700 (Gliddon), 2400 (Prichard), 2387 (Knoetel), 2330 (Wilkinson), 2224 (Palmer), 2182 (Hofmann), and so on. See Wuttke's Gesch. der Schrift, Leipz. 1872, p. 488. This confusion, however, is much more enormous indeed; because from Menes to the Lagides there is not even a single one of Manetho's 31 dynasties and of his 300 kings placed in the same year by the said authors. How came this to pass? Manetho's Grecian history, written in Greek for Ptolemæus Philadelphus, 280 B.C., perished, and we possess only a few excerpts preserved by Josephus, Julius Africanus, Eusebius and his Armenian translator. None of these authors says with so much as a word whether Manetho's dynasties had ruled one after the other, or simultaneously. The aforesaid chronologers, however, preposterously stated all Manethonian dynasties to have been successive ones. The Vetus Chronicon, it is true, reports that the first 13 Egyptian dynasties ruled simultaneously in different provinces; but Syncellus, who saved the Vetus Chronicon, being a father of the Church, was charged with having committed a pious fraud, and therefore his report that Menes reigned since the beginning of the first Canicular period in 2780 B.C. was condemned. Besides, Josephus, Julius Africanus, Eusebius and his translator refer, nearly in all instances, to the same dynasty and the same king's different reigning times; and hence the present unparalleled chaos of Egyptian history is natural.

It being evident that upon the Egyptian names of the planets it depends to understand the Egyptian names and emblems of the signs of the Zodiac, to explain the religions and the deities both of the Egyptians and all other pagan nations, to decipher numerous planetary configurations of old, to destroy a hundred aërial castles, and to restore the real history of Egypt, etc., it is worth while to examine a papyrus which clearly and reliably furnishes the required information.

I. *The Names and Emblems of the Planets.*

In 1826, during my researches in the Museum of Turin, I was informed that this institution preserved a large chest containing half a million of papyrus fragments, already examined, two years earlier, by Champollion of Paris. On looking at them I noticed at a glance that many of them once belonged to a historical papyrus similar to Manetho's history. Hence I resolved to reëxamine the same chest, and to reunite, as far as possible, the dismembered pieces, which was done after six weeks of arduous toil. This is the origin of the so-called autograph of Manetho at Turin, soon after (but in many places incorrectly) published in Lepsius's

"Auswahl Ægyp. Urkunden." He did not add one word of interpretation or make use of its contents in publishing his Egyptian Chronology, because it is easier to copy, more or less correctly, Egyptian inscriptions instead of translating them. Other particulars will be found in these Transactions, vol. iv. p. . . .

The hieratic papyrus under consideration begins the history of Egypt, like the Greek Manetho, with the reigning of Vulcan, the creator of the world. After him we see the names of the 7 great gods, the Cabiri, i.e. the seven planetary gods, called regents. The next class of Egyptian princes, Manetho's heroes, or 12 Semidei, are the 12 gods of the Zodiac, the wardens of the houses of the planets. These two divine dynasties are then followed by Manetho's human kings of the first Egyptian dynasty: Menes, Athothes, etc. These mythological dynasties, moreover, are divided from each other and accompanied by fabulous ciphers, referring to their astronomical reigning times, which are irrelevant. The name of each king occupies a peculiar line on the Turin papyrus, and in the same order in which they are represented on our Plate, line i., Nos. 7, 6, 5, 4, 3, 2, 1. The same names, hieroglyphically represented, will be found on Plate I. underneath the hieratic groups. The following is their grammatical interpretation:

No. 7, which is the first regent of this planetary dynasty, corresponds to Manetho's *Κρόνος*, Saturn, and from Joh. Malala' (Cramer's Anect. Par. ii. p. 385) we learn that the Egyptians called Saturn *Κήβ*, from which the corrupted Coptic word ⲥⲏⲟⲩ, ⲥⲏⲩ (sev), time, originated, because ⲩ after vowels sounds *v;* and *k*, being softened, becomes *s*.. Comp. ⲥⲓⲟⲩ, star, the ancient כב (kab), star, apart from a hundred similar words. Besides *κρόνος* and *χρόνος* are notoriously the same words. Moreover, the gander ⲛⲉⲛⲉⲥⲱⲱⲥ, the Greek *χήν*, sounds *k*, and not always, as the Champollionists imagine, *s*. For our Plate II. iv. v. vii. No. 10, expresses the same word gander by the arms, and his substitute, the egg, notoriously signifying *g*, *k*. (See the author's Gram. Æg. p. 65.) Hence our group is to be spelled *kb*, like *κήβ*, the aforesaid name of Saturn, corresponding with the Hebrew and Arabic כיון (kina–n), Saturn. The added figure of a man (ⲣⲱⲙ) forms the word the-man-of-time, and this is apparently *κρόνος*, χρόνος. The following deities, Jupiter, Mars, Venus, Mercury, and the Moon, are on our papyrus enumerated according to their apparent velocities; because the revolution of Saturn is the longest, that of the Moon the shortest.

No. 6, the planet next to Saturn, Jupiter, is Manetho's Ὄσιρις, the old Hosiris. Indeed, the throne ϩιсє, the Hebrew כסא (kisse), signifies *hs* in Hisis and other words. The eye (Plutarch Is. 10, 355) expresses *ar*. Hence the figure of a man forms with the preceding *hs ar* the name ϩⲁⲙⲉⲣⲓϫⲓ, the sitter or judge, punisher.

No. 5, a man with the head of the Tapir Indicus, represents Mars, the next planet after Jupiter. The tapir, a kind of hog, the Greek σῦς, the Latin *sus*, the corrupted ϵϣω, expresses *ss* in Sesos-tris and *s* in Osimanthyas (Gram. Æg. p. 62), because ϩⲁⲙ ϣⲓϣ, the man of vengeance, characterizes the god of war, Mars.

No. 4, the sparrow-hawk, stands very often instead of the letters *kr*, in later times pronounced *hr*, e.g. in Horus (Gram. Æg. p. 69), expresses different words containing the same letters *kr*. Hence we have here the word ϩⲁⲙ σⲉⲣⲉ, ϫⲉⲣⲉ, עהר (kahar), ardere, fulgere, which are epithets applicable to Venus.

No. 3, the well known ibis, an emblem of Mercury, Thoth, expresses very often *at*, *tt* (Gram. Æg. p. 67), hence ⲁⲧ-ϩⲏⲛⲧⲉ, *invisibilis*, because Mercury is commonly invisible; and therefore, as the joined figure of an ape demonstrates, Mercury was frequently designated by the figure of an ape (כוף. kop, κῆπος) for expressing חפה (chapa), ϫⲉⲛ, *tegere*, *obscurare*. Comp. Euseb. P. E. i. 9, p. 31: Θώθ Ἑρμῆν Ἕλληνες μετέφρασαν. Syncel. i. 172 (Dind.): Ἀθώθης . . . οὗτος ἑρμηνεύεται Ἑρμογένης.

No. 2 signifies the Moon, because she follows Mercury. The group itself, however, contains the name of king Menes, which signifies the son of the Moon; to-wit, the pedestal or step, commonly underlying the throne of Osiris, being called ⲙⲟⲛⲓ, *scala*, very often replaced by an ostrich feather (ⲙⲁϩⲓ, ancient ⲙⲁϫⲓ), expresses the word מג (mag), *magnus*, related with μέγας, ⲙⲏϣ. Grammat. Æg. p. 93, No. 483. The sickle (מגל, magal, ⲙⲁϫⲟⲩⲗ, μάχαιρα) expresses μάκαρ, *beatus*, *defunctus*, and then the deified soul of the defunct. Hence the first part of this group signifies the great Manes, i.e. Menes, the progenitor of the Egyptian nation.

The ostrich feather (ⲙⲁⲕⲓ), the equivalent of the step (ⲙⲁⲕⲓ), expresses likewise *mk*, and hence the name of the Moon, "Maja" (*sancta*), "the mother of Mercury" (the ancient Moon), related with Maga. That the ostrich feather, followed by the letters *tkn*, ϯⲕⲏⲛ, i.e. γύνη, signifies the moon, will be seen on our Pl. II. iv. v. vi. vii. No. 5. The following viper ⲁⲕⲱⲣⲓ, very often expressing *kr* (Gram. Æg. p. 73, No. 326) gives the word גול (gul). χόρος, the corrupted ϣⲏⲣⲓ. The whole of the group, then. contains the following sentence: the great Manes, the son of the Maja genitrix; i.e. Menes, the son of the Moon.

No. 1, finally, must contain the name of the resting planet, that of the Sun. Indeed, since the sparrow-hawk signifies a variety of words containing *kr*, as we have seen on p. 415, we obtain by it the notorious name of the sun חור (chur). χύρος, ϩⲣⲁ (ϩⲣⲁ), ἥλιος (χήλιος), sol, (kol), &c. All these synonyms refer to the root ϭⲉⲣⲉ, ϫⲉⲣⲉ, קל (kala). צהר (kohar). יור (jeor). *lucere*, *splendere*, *urere*. The appended scourge, ⲕⲗⲏⲙ, furnishes the word χορηγή, the corrupted ϣⲟⲣⲡ. *princeps*, by which the sparrow-hawk of the Sun was distinguished from that of Venus, No. 4. Comp. Antonius Lib. Fab. xxviii. The following words *tri* and *sb*, belonging to the roots ⲑⲣⲉ, דור (dur). *fingere*, *creare*, and ϣⲟⲧ, *validus*, signify the sun, as the mighty creative power.

These are, then, the primitive Egyptian names of the seven planets, so long sought for, on which a new series of important discoveries depends.

In the next place, it must be borne in mind that the Egyptians represented the planets not only by their common names but also by their emblems, as has been explicitly demonstrated in the author's Astronomia Ægyptiaca; to-wit, according to Egyptian philosophy, each planet presided over a number of natural objects, which were called its "ducatus." To the ducatus of a certain planet all the animals, trees, and other phenomena, were numbered which appeared most related with the true or imaginary nature of the planet. Hence the different animals kept in the Egyptian temples of different deities, and hence the strange gods and goddesses ornamented with peculiar animal heads, plants, and the like, are to be explained. The same we find in Greece and Italy, e.g. the eagle associated with Jupiter, the owl conjoined with Minerva.

The seven emblems of the seven planets, opposed to their common names (Plate I. l. ii), are taken from the great Turin Hymnologium (Lepsius's Todtenbuch, Pl. LX. & LXI.) Each of them holds two knives, called ϫοτ, in order to express the word κοτ, planet.

Saturn (No. 7) is symbolized by a crocodile, because Saturn was presumed to be a destructive deity, like the crocodile.

Jupiter was the god of the priests, judges, kings (Astronomia Ægyp. p. 198), and hence his emblem was the figure of a priest (No. 6).

Mars, the god of war, violence, murder, and the like, was mortiferous like the viper, and hence the figure of a viper-headed man was his symbol (No. 5).

Venus, the star of love, is characterized by a cat, this animal resembling the nature of Venus (No. 4), called Hathor. Comp. חתול (katul), Kater, cat.

Mercury, always accompanying the sun and imitating its motions, is very conveniently represented by the figure of an ape, because the latter likes to imitate the actions of his master (No. 3). Besides, the ape קוף (kop), κῆπος, signifies syllabically חפה (kap), *obscurus*, because Mercury is seldom visible.

The moon's house in the Zodiac was originally expressed by a lioness, and hence it is evident that this animal must have belonged to the ducatus of the moon. The affinity of the queen of the animals to "the queen of heaven" needs no demonstration.

The figure of a turtle-headed man must, finally, refer to the sun, but it is not clear why the ancients symbolized the sun by a turtle. Greek mythology gives Apollo Musagetes, i.e. the Sun-god, the turtle, because he formed out of the latter the first lyre. Is it the globular form of the turtle and the sun which gave rise to this symbolization?

The next principal question is, How did the Egyptians call and symbolize the 12 signs of the Zodiac?—to which we now proceed.

II. *The Names and Emblems of the 12 Signs of the Zodiac.*

It is to be remembered that all ancient nations called the signs of the Zodiac the houses of the planets, and it is well known what planets the single signs presided over. The whole Zodiac was divided into two equal parts, which touched each other in the points of the winter and summer solstices, as follows: The planets Saturn, Jupiter, Mars, Venus, and Mercury, possessed each two houses, one east, the other west of the winter solstice, as here shown, the Sun and the Moon receiving only one sign each.

Leo.	Cancer.	Gemini.		Taurus.	Aries.	Pisces.	Aquarius.	Capricornus.	Sagittarius.		Scorpio.	Libra.	Virgo.
♌	♋	♊	*	♉	♈	♓	♒	♑	♐	*	♏	♎	♍
☽	☿	♀		♂	♃	♄	♄	♃	♂		♀	☿	☉

It is apparent that the same symbolism which, e.g., made the crocodile an emblem of Saturn, the lion that of the Moon, &c., selected the animals symbolizing our signs of the Zodiac; for Sagittarius belonged to the ducatus of Mars, Gemini characterized Venus genitrix, and so in all other cases. By the way, the fact that the originator of the Zodiac put the winter solstice between Aquarius and Pisces, the houses of Saturn, etc., brings to light the fact that our Zodiac must have been invented about that time when the winter solstice lay between the houses of Saturn, the constellations of Aquarius and Pisces. In consequence of the precession of the fixed stars the vernal equinoctial point lies to-day in the midst of the constellation Pisces, consequently about 72° west of its original point; therefore our Zodiac must have been arranged about the year 5800 B.C.

Concerning the names and emblems of the signs of the Zodiac on the Turin papyrus, it is to be lamented that they are broken off, except the first. Since this first part of the Zodiac is, on our papyrus, expressed by the sparrow-hawk, the emblem of Venus (Pl. I. l. ii. 4), and since all nations commenced the Zodiac with the vernal equinoctional point, it is evident that the figure of the said sparrow-hawk represented the first sign of the Zodiac, the house of Venus, Gemini, the first sign after the vernal equinoctial point in 5800 B.C.

Manetho's copiers and the Vetus Chronicon specify 8 Semidei or Heroes after the 7 Cabiri, referring to the 12 signs of the Zodiac; but their catalogues—*Ἄρης*, *Ἄνουβις*, *Ἡρακλῆς*, *Ἀπόλλων*, *Ἀμμών*, *Τιθοής*, *Σῶσος*, *Ζεύς* — are apparently incomplete, and the orders of these deities differ in some instances. *Τιθοής* is identified both with Tulis or Tutis and *Ἄνουβις*, besides he stands before Ares; Ζεῦς is called Osiris. The specified Semidei refer probably to the 12 signs as follows:

♌	♋	♊	♉	♈ ♓	♒	♑	♐	♏	♎	♍
—	Anubis.	Apollo.	Mars.	Ammon. —	—	Osiris.	Sosos.	—	Tithoes.	Hercules.

At present, therefore, the shortest way for determining the names and emblems of the wardens of the 12 signs of the Zodiac is to examine the astronomical inscriptions on which the 12 signs of the Zodiac, according to their order, are represented. Of this description is the sarcophagus at Leeds, England, explained in these Transactions, vol. i. p. 356. I am sorry, however, that the inscription on the right hand side of the mummy-coffin was there represented incorrectly, because Mr. W. Osborne in his pamphlet entitled "An Account of an Egyptian Mummy," etc., Leeds, 1828, had failed to publish an exact copy of that part of the monument. In 1860 Mr. Henry Denny, then the meritorious Secretary of the Leeds Philosophical and Literary Society, who died this year, was so kind as to send me a new and complete copy of the imperfectly represented inscription on the right side of the coffin, which copy is to be found in my Bibliotheca Ægyptiaca manuscripta, vol. xiv. p. 11, 544. According to this new copy, the inscription on the right hand side of the coffin has been lithographed on our Plate l. xi.

This coffin representing on both sides the 12 signs or houses of the planets according to their common order, it will be an easy matter to determine nearly all names and emblems of the signs of the Zodiac. Remember that the cup (l. ii. *a*. 5), called ⲁⲛⲟⲧ, expresses syllabically בית (*beth*), ⲁⲃⲏⲧ, ⲁⲧⲏⲧ, *mansio*; consequently, the 5 figures bearing this goblet on their heads (l. ix. 6, and l. xi. 3, 4, 5, 8) must be signs of the Zodiac; and since the latter run, on both sides of the coffin, from the head to the foot, in the following direction, ^{5}♎, ^{4}♍, ^{3}♐, ^{2}♑, ^{1}♒ || ♓^{1}, ♈^{2}, ♉^{3}, ♊^{4}, ♎^{5}, we understand easily what signs are signified by the said cup-bearing figures, and their names.

L. xi. 8, spelled ⲛⲧⲏ, but commonly ⲛⲏⲧ, is the well known Egyptian Νέφθυς, Venus, Urania, the sixth sign after ♎, i.e. ♒, the house of Saturn. See my Astron. Æg. p. 137.

L. xi. 5, spelled *nt*, signifies Νηίθ, the Egyptian Bellona, accordingly the house of Mars, namely, ♉. See my Astron. Æg.

p. 136. Comp. Plutarch Tim. p. 21; Νηίθ, Ἑλληνιστὶς Ἀθηνᾶ, the female Mars, Bellona.

L. xi. 4, spelled ϣⲟⲛ, ϩⲱⲗⲕ, the Hebrew ארג (arag), denotes Venus, the maker of *texturus*, because she was the Œcodespota of ♊.

L. xi. 3, spelled *kr-t kt*, probably ⲟⲩⲣⲟ-ⲧ, (ⲕⲟⲩⲣⲟ) ⲕⲁϯ. ידע (jada), the lord or queen of wisdom, clearly denoting Thoth, Hermes, Mercury, ♋.

L. ix. 6, spelled *tbn nhpt*, signifies the house of Jupiter, Aries; for ⲧⲉⲃⲛⲏ is notoriously animal, ζῶον, and the globular vase (*n*) with the clew (*hpt*) furnishes the words ⲛ ϩⲟⲩⲓⲧ (*caput*), of the regent. The clew (ϩⲱⲛⲧ, בד, bad), expresses very often בד, *membrum;* in full, *hbt*, *hpt*, and never *o*, as Champollion imagined. Moreover, the planet Jupiter was the god of the kings (l. ii. 6), and the insignia of Jupiter Ammon were the horns of a ram, his emblem. Hence our group calls Aries the animal of Jupiter. See my Astronom. Æg. p. 142. Besides, this group is not to be confounded with that of L. iv. v. vi. 5, which signifies תוא (thava), Capricornus, the other house of Jupiter.

Moreover, the Leeds mummy-coffin furnishes many other names and emblems of the wardens of the 12 signs, for all the names and figures characterizing a certain planet are Œcodespotæ in case they occupy a sign of which the same planet is the warden. We specify the following:

L. ix. 3, the acknowledged name and emblem of Mercury Anubis is ♋, the house of Mercury.

L. ix. 4, the well known name and figure of *bn nbt*, ⲃⲏⲛⲉ, phœnix (and not, as Peyron imagined, *hirundo*), the Latin Venus, called ⲛⲟⲩⲃⲧ, *textrix*. The same by-name is given to Venus in L. xi. 4., because she moves constantly from west to east and vice versa, like the weaver's shuttle. Consequently this Venus represents the warden of Gemini.

L. ix. 5, the house of Mars (♉), as we have seen, is occupied by a god bearing a lotus-flower (ⲕⲏⲣ-ⲟⲉ), which gives the word ϫⲟⲣ, mighty, an epithet of Mars. The added name furnishes, in the next place, by the lute נבל (nebel), the word נבל (nibel), the despiser, and by the following letters *amte* (ⲁⲙⲁⲣⲧⲉ), mighty, the idea being "the destroyer of the mighty."

L. xi. 13, represents Mars in the house of Mercury (♎), and this sign is expressed by a fence (חח. cheth), including a sparrow-hawk (Horus), which group signified, as Plutarch says, *domus mundanæ Hori*—Scorpio, the house of Venus. Plate I. l. iii. 6.

All these names and emblems of the signs of the Zodiac or their wardens are confirmed and completed by many other astronomical inscriptions representing the 12 signs according to their regular order. We specify the sarcophagus in the British Museum, No. 23, explained in my "Berichtigungen der alten Geschichte," p. 169; further, the sarcophagus No. 3 of the same museum, deciphered in the same Berichtigungen, p. 174; and the planetary configuration of Ptolemæus Epiphanes, represented in Young's Hieroglyphics, Pl. 67.

Having thus determined the elements of Egyptian astronomy, namely, the primitive names and emblems of the 7 planets and those of the 12 signs of the Zodiac, we proceed now to

III. *The Interpretation of some very important Planetary Configurations.*

A planetary configuration, we understand, is a representation of the seven planets, Saturn, Jupiter, Mars, Venus, Mercury, the Moon, and the Sun, together with the segments of the Zodiac, with which the former were conjoined at a certain epoch of history. In order to understand inscriptions of this kind, it is to be borne in mind that the ancients were in the habit of observing the places of the planets on the cardinal days, and recording them in their temple annals; that they fixed the longitudes of the respective planets according to the movable signs of the Zodiac; and in case two planets occupied the same sign, then they specified the Decuriæ of the sign in which the respective planets appeared: to-wit, each sign was subdivided into three parts of 10 degs. each, which were likewise presided over by the planets, as has been shown specifically in the writer's Astronomia Æg., Pl. I. E.g., the first sign after the vernal equinoctial point (♈ 0°) containing the Decuriæ of ♄, ☉, ♀; suppose ♄ to have once occupied the Decuria of ♀, but ♃ that of the ☉ in ♈, then the Egyptians represented ♃ in the house of the Sun, but ♄ in that of ♀. All these particulars have been handed down by ancient astronomers, especially by Firmicus and an Egyptian papyrus, the nativity of Anubis, written in Greek. See my Astron. Æg. p. 213.

How important all such planetary configurations are for ancient history and chronology needs no exposition; for the Egyptians, Greeks, and Romans, being destitute both of the Copernican system and planetary tables, could not calculate earlier longitudes of the planets; the places of the planets on ancient astronomical monuments were really empiric observations, and therefore reliable. It is, moreover, an easy matter to determine the date of any ancient planetary configuration by means of our planetary tables, because these are based on exact modern observations and on the multiplication table. Besides, no ancient planetary configuration can return twice during a period of 2146 Julian years. Suppose Menes to have settled in Egypt on that day in which the ☉ stood in ♍ 0°, the ☽ in ♑, ♄ in ♒, ♃ in ♊, ♂ in ♒, ♀ in ♍, ☿ in ♍, a similar planetary configuration could return only after 2146 years. During this period 113 renewals of the lunar cyclus of 19 years, 74 revolutions of Saturn, 179 revolutions of Jupiter, 67 revolutions of ♂ (of 32 years each), 268 revolutions of ♀ (of 8 years each, and 165 revolutions of ☿ (of 13 years each) were performed, the fractions being neglected. Supposing, then, Menes to have settled in Egypt, as the ancients report, at the beginning of the first Canicular period, and on that day the planets to have stood in the aforesaid signs, it incontrovertibly follows that Menes entered Egypt either in 2780 or 634 B.C. The same, of course, is the case with all other planetary configurations of the ancients; none of them could occur twice during 2146 years. See the author's Astron. Æg. p. 50.

By the way, since the astronomers maintain that the accelerations of the moon's motions are periodical only, and that they are effected by the attractive powers of the planets, it is evident that the perturbations of the moon by the planets must commence anew as soon as the seven planets return to their former places after 2146 years; during which, moreover, the precession of the fixed stars amounts to nearly 30 degrees, an entire sign of the Zodiac. It is strange, indeed, that the astronomers from Ptolemy to this day failed to recognize this long planetary period, and, whilst determining the secular accelerations of the moon, to take it into account. It was discovered as early as 1846, and referred to the ancient twelve ages of the world. See the author's Chronologia Sacra, p. 189.

1. Planetary Configurations concerning the beginning both of the first Canicular Period and the Egyptian Empire.

At present there are 14 monuments known on which the planetary configuration represented on our Plate, Nos. iv. v. vi. vii., has been preserved. They have been copied by Lepsius (Ueber den [?] ersten ægyptischen Goetterkreis und seine geschictlich [?] mythologische Entwickelung; Berlin, 1851), and published, as was natural, together with a totally wrong interpretation. Lepsius, in fact, imagined those 14 deities to have been the 14(!) aboriginal solar deities of the Egyptians. It is only strange how it came to pass that those 14 solar deities disappeared since the year 3892 B.C., and finally, in 2780 B.C., coagulated to one clump.

Since all these 14 inscriptions, apart from unessential points, agree with each other, we reproduce only the most clear ones and those in order to illustrate the first.

No. iv. is to be found on the temple of Osimandyas (1730 B.C.) at Thebes, which was, as Lepsius fancied, the temple of Mars. But the group L. iv. No. 16, is to be spelled *knk* and not *kns*, because the onion was called *kari*, and not *sari*, as Champollion imagined. Moreover, it is true that the Etym. M. s. v. Χῶνες says, τὸν Ἡρακλῆν φασι Χῶνα λέγεσθαι: but Hercules is not Mars but the Sun, and Chon differs from Chons. In short, *knk* is our king; Ger., König; Swed., kung. See the Dictionary of the immortal Webster, s.v. king.

No. v. ornaments another temple of Thebes of the same age.

No. vi. is to be found in Burton's Excerpta Hieroglyphica, vol. i. Pl. 15.

No. vii. is the engraving on the Turin and Paris cubits, purposing to remember that this cubit was the same that Menes brought from Babylonia into Egypt in 2780 B.C.

In the first place, everybody notices (L. iv.) the 7 planets, according to their natural order, conjoined with 7 signs of the Zodiac; for the Turin papyrus, as we have seen (p. ——), shows that *kb* (No. 10) was Saturn and Osiris (No. 8) was Jupiter. The name of Mars is expressed by the letters *krhti*, planet, or *deus terribilis*, κοτρο, ϩοτε, which is confirmed by l. vii. 6, where the same Mars is expressed by the tapir, signifying Mars in the Turin papyrus (L. i. 5). The following planet ♀ (iv. 4) is represented by the sparrow-hawk, signifying ♀ on the Turin Manetho (i. 4). The next is ☿, expressed by the letters *tr nn*, perhaps ⲟⲣⲟ ⲛⲁⲛⲉ, the juvenile planet. This being doubtful, it is a fact that all other copies put in the same place "Thoth" (v. vi. vii. 2), the common term for Mercury. The first planet of our row is called *mnt*, ⲙⲟⲛⲉ ⲑⲟ, the pastor of the world — which obviously denotes the sun, because, in the parallel places, it is expressed by the well known pupil, signifying the sun in numberless places. Finally, the last of the 7 planets, the moon, is expressed by the same ostrich feather by which our Turin papyrus signified the moon in L. i. No. 2, as we have seen. At present every intelligent man can see with his own eyes what Lepsius's seven solar deities properly signified, namely, the usual row of the seven planets, as follows:

♄ ♃ ♂ ♀ ☿ ☽ ☉

We proceed now to another question, viz., with what signs the seven planets are conjoined on our four monuments. Previously, it is to be remembered, all deities bearing a cup (ⲁⲛⲟⲧ) on the head signified houses (ⲁⲑⲏⲧ, בית. beth) of the planets; and it is self-evident that the Œcodespotæ sitting with a planet upon the same sofa (*lectica*, κλίνη) express the signs of the Zodiac in which the respective planets were then sitting. The planets, because of their superiority, occupy always the first place on the right hand.

L. iv. 13, brings the sun in conjunction with *tamh*, called also *atm*, *tam*; and this is the undisputed Coptic name of Virgo (♍), viz. ⲑⲟⲑⲙⲉ. Consequently the sun stood at that time in ♍, i.e. because the Egyptians observed planetary configurations on the cardinal days (p. 421) in ♍ 0°. This result is confirmed in L. vii., where ♍, the house of the sun, is expressed by the sparrow-hawk, signifying *kuro*, the sun, as the Turin papyrus (ii. 1) has demonstrated.

L. iv. 11, calls the sign with which the moon was conjoined *tb*, the name of Capricornus, as we have seen above; for *tb* is תוא (thava), *dorcas*. Since L. vii. 11, expresses the name of the same sign by *kb*, the Hebrew צבי (kebi), *dorcas*, ϭⲓⲉⲓⲉ, we see that the moon then stood in ♑. The proper image of this Capricornus will be seen in my "Berichtigungen der alten Geschichte," p. 137.

L. iv. 9, refers Saturn to ♒, as we have seen above. Comp. L. xi. 8, Venus Urania.

L. iv. 7, shows that Jupiter stood on the same day in ♊, the house of Venus (L. xi. 4), represented by a goddess decorated with a horned disk (L. v. 7), because this planet very often appears horned even to the naked eye.

L. iv. 5, Mars in conjunction with a segment of the Zodiac of which the planet Mercury was the warden (L. xi. 3). The same ♂ is in L. v. vi. and in many other places expressed by a decapitated man or even by the two *venæ jugulares* alone, because decapitation belonged to the ducatus of Mars. But, query: how is it that L. v. vi. and others place the two planets, viz. Saturn and Mars, in the same house of Mercury? And how is it that Saturn, when all other inscriptions refer to Aquarius (iv. 9, v. 9, vi. 9, vii. 9), reappears in the house of Mercury together with Mars? The answer is at hand. Saturn and Mars must have been in conjunction in the same sign, namely, because it occupies ♒ alone, in Aquarius. This sign, preceding the winter solstitial point, contains the Decuria of Mercury (♒ 0°–10°), that of the Moon (♒ 10°–20°), and that of Saturn (♒ 20°–30°). See the author's Astron. Æg. Pl. I. Since, then, ♄ reappears conjoined with ♂ in the Decuria of ☿ in ♒, it is evident that on that day ♄ and ♂ must have stood in ♒ between 0° and 10°. Besides, the planet with the head of a crocodile must be Saturn, because this animal belonged to the ducatus of Saturn (L. ii. 7), and the letters *sbk* contain the name of the crocodile ⲥⲟⲩⲭⲓ, the old Sovchi. The name of Mars, bearing the *venæ jugulares*, written *trnnnn*, i.e. ⲑⲟⲣⲓ ⲛⲟⲉⲙ ⲛⲛⲛⲓ — "the horror of the arrogant mutineers"— clearly characterizes the god of war and vengeance. The name of the Decuria of ☿ is called *avns*, because the chessman or rook אבן (eben) by which the name of Heliopolis און (aven) was called, furnishes the name of Mercury: ⲁⲧⲁⲛ, inconstant, fallacious.

L. iv. 3, refers the planet Venus to ♏, the house of ♀ (L. iii. 6). Since, however, the elongation of ♀ from the sun never amounts to more than 48 degs., it is apparent, that, the sun standing in ♍ 0° and half in ♌ 30°, Venus could not have been seen in ♏ 60° east of the sun. That house of ♀ to which Venus is referred must again be a Decuria of her. Since, however, the ancient Zodiac from ♋ 0° to ♏ 0° does not contain any Decuria of ♀ except that in ♏ 10°–20°, it is self-evident that Venus on that day must have stood in ♏ 10°–20°, i.e. east of the sun.

Finally, ☿ being posted in the house of Mercury (L. iv. 1, v. 1, vi. 1, vii. 1), and his distance from the sun never exceeding 29°, and from ♌ 0° to ♍ 30° no house of ☿ existing, it is again clear that the longitude of ☿ must refer to a part of the signs ♌ or ♍ presided over by Mercury. See my Astron. Æg. Pl. I. Here it is to be remembered, that, in case a planet occupied both a sign and a Decuria presided over by the same planet, the Egyptians recurred to a smaller division of the same sign. Hence Mercury, standing together with the Sun in the same sign and the same Decuria of the Sun (♍ 0°–10°), was to be referred to a Horion contained by that Decuria of the Sun. The aforesaid Plate shows that in ♍, Dec. ☉, only one Horion of ☿ existed, comprising the first 7 degrees of ♍. Consequently Mercury must on that day have stood in ♍ 0°–7°.

The result of this simple disquisition is that on the solstitial day of a certain year the places of the 7 planets in the Zodiac were these: ☉ between ♌ and ♍, ☽ in ♑, ♄ in ♒ 1°–10°, Jupiter in ♊, ♂ together with ♄ in ♒ 1°–10°, ♀ in ♍ 10°–20°, ☿ in ♍ 0°–7°. This planetary configuration, which could occur but once during a period of 2146 Julian years (p. 422), and which has been preserved on 14 Egyptian monuments, in what year may it have taken place? The question is easily answered.

The inscription L. iv. and several others have been found on temples of Osimandyas in Thebes, who ruled since the year 1730 B.C. See the writer's "Berichtigungen der alten Geschichte," p. 179. Consequently the planetary configuration under consideration must refer to an earlier year.

Further, in front of the 14 planetary and zodiacal deities (L. vi.) king Menes is represented receiving the benediction of the former. For the crescent ⲙⲁⲛ. *Μήν*, מני (meni). &c., expresses syllabically the name of Menes; and the person itself, standing upon the crescent, bears the royal insignia, the usual royal crown with the uræus (ⲁⲕⲱⲣⲓ, i.e. ⲕⲟⲩⲣⲟ, king), the sceptre, and the crux ansata (*ank*, i.e. *ἄναξ*). Moreover, instead of the crescent opposed to the planets, we find several times the figure of a poppy-head (L.

iv. 15), ⲛⲉⲙⲁⲛ, i.e. the flower of the moon, which likewise signifies syllabically both the moon and king Menes. Add that this Menes is (L. vii. 15) expressly called *kn hm*, i.e. ϩⲁⲙ ⲕⲏⲛ, the progenitor (of the Egyptians). Besides, the Vetus Chronicon testifies that Menes and his sons ruled since the beginning of the first Canicular period, July 19th, 2780 B.C. Even the Tablet of Abydos specifies 34 kings from Menes to Osimandyas, who ruled since 1730; and since, at that time, each king reigned summarily 30 years, Menes must have ruled 1020 years prior to Osimandyas, i.e. about 2750 B.C. Eratosthenes specifies from Menes to Osimandyas (inclusive the omitted Σταμμενεμῆς ά) 35 kings, and hence Menes would have reigned since 2780 B.C. Eratosthenes gives the time of the same kings from Menes to Osimandyas as 970 years, or, including Stammenemes I., 1000 years. Accordingly, Menes would have settled in Egypt 1000 years prior to 1730 B.C., i.e. 2730 B.C. Finally, the Tablet of Karnak preserved the names of the kings who ruled in Mizraim, i.e. the eastern and western parts of the Delta, from Menes to Thuthmos IV. (1866 B.C.) One of these catalogues enumerates 30, the other 28 kings from Menes to the said king; and, since regularly each king ruled a human age, Menes must have occupied Egypt either in 2766 or 2706 B.C. according to the Tablet of Karnak. In short, all these historical traditions concur in confirming the testimony of the Vetus Chronicon, that Menes reigned since the beginning of the first Canicular period in 2780 B.C.

Let us now see whether this result is mathematically confirmed by our 14 planetary configurations observed on the day of Menes's arrival in Egypt. It is to be remembered that our Planetary Tables express the point of the summer solstice by $3^s\ 0^\circ$, that of the winter solstice by $9^s\ 0^\circ$, and the points of the equinoxes by $0^s\ 0^\circ$ and $6^s\ 0^\circ$. Our approximate computation refers to -2780, July 16, 6h. (Paris time), which was the day of the summer solstice (p. ——).

Ancient Observation.		*Computation.*
☉	$3^s\ 0^\circ$	☉ $3^s\ 0^\circ$
☾	$7^s\ 0^\circ - 30^\circ$	☾ $7^s\ 3^\circ$
♄	$8^s\ 0^\circ - 10^\circ$	♄ $8^s\ 4^\circ$
♃	$0^s\ 0^\circ - 30^\circ$	♃ $0^s\ 13^\circ$
♂	$8^s\ 0^\circ - 10^\circ$	♂ $8^s\ 6^\circ$
♀	$3^s\ 10^\circ - 20^\circ$	♀ $3^s\ 15^\circ$
☿	$3^s\ 0^\circ - 10^\circ$	☿ $3^s\ 2^\circ$

A more exact computation will alter our longitudes of the planets by a few minutes or degrees, which makes, however, no difference at all concerning the year and the day of the observation. The observer's place, moreover was Tanis, the ancient צען (koan), on the eastern boundaries of the Delta, where, as Manetho reports, Menes resided and reigned. The time of the observation was probably midnight in Tanis, because at that time the stars were most clearly visible.

In conclusion, I challenge all Egyptologists to demonstrate, by means of their astronomical friends, that the aforesaid 14 astronomical inscriptions refer to the year −6467, or −5867, or −5773, or −5702, or −5652, or −5613, or −5303, or −4915, or −4890, or −4455, or −4400, or −4175, or −3895, or −3892, &c., to which different years the Champollionists have referred Menes. The only man who commenced Egyptian history with the true year was the late Prof. Dr. M. Uhlemann, at Göttingen. It is to be lamented that this distinguished scholar, who was much better qualified to promote Egyptian philology than all the Champollionists together—the author of the best Coptic Grammar, and many other valuable works—who understood Hebrew and all other languages necessary in translating Egyptian works of literature—who, being endowed with good common sense, continually refuted Egyptian absurdities, and defended my little discoveries against the unclean hands of filibusters;—that such a man died in the bloom of life I cannot but deplore, and must not fail, on this occasion, to lay upon the grave of my honored friend the well merited wreath of laurel.

Concerning myself, should the Champollionists finally convince me that there exists any man on earth, or power in heaven, to change the multiplication table, and to bring Menes to another year than that of 2780 B.C., 666 years subsequent to the deluge, I will sing with Horatius,

"Exegi monumentum ære perennius";

not claiming any merit, but because the melancholy drama, called "Manetho," lately so ingeniously reënacted by Lepsius, has played out forever.

2. *Planetary Configurations of Pharaoh Horus of the XVIIIth Dyn., 1780 B.C., Plate* I. l. viii.

The planetary configuration represented on our Plate, l. viii., was discovered A.D. 1830 by Prof. Rosellini, of Pisa, on the temple of Horus (l. viii. Nos. 15 & 16) in Thebes, and published in his "Monumenti dell' Egitto e della Nubia," vol. iii. No. ii. The common names and emblems of the 7 planets and of the 12 signs of the Zodiac being recognized in the premises, it will be an easy problem to explain the single deities, and to determine the date of the observation.

In the next place everyone sees that the deities Nos. 13 and 14 are conjoined with each other, because the following figure puts its hand upon the shoulder of the preceding planet. Thus the conjunction of a planet with a zodiacal god is expressed similarly to the planetary configuration of Menes l. iv. The same is the case with the two figures Nos. 3 & 4. Further, Nos. 9 & 10 and 11 & 12 are likewise united with each other, and consequently the two planets contained in this group must have occupied two consecutive signs of the Zodiac. The next group of four copulated deities signifies the same.

Further, the Egyptians, as we have seen (p. 411), were in the habit of placing the figures of the planets before those of the zodiacal deities; accordingly the figures 14, 12, 10, 8, 6, 4 and 2 must express the seven planets as follows. Previously we understand that the planets were again enumerated according to their apparent velocities, like the planetary configuration of Menes (l. iv.)

L. viii. No. 14, called *Amun kre*, i.e. ⲁⲙⲟⲩⲛ ϭⲉⲣⲉ (Jupiter splendent, represents the planet Jupiter; for the ancients very often paralleled Amun with Jupiter. It is a mistake of Champollion to translate this name always by "Amun-ra, the Sun-god." See my Astron. Æg. p. 97.

No. 12, called *Pth kr mkt*, ⲡⲧⲁ ⲣ ⲕⲟⲩⲣⲟ ⲙⲏϣ (r. מָג, mag) is the well known Phtha, the lord of the hosts, Mars. His name is expressed by a bald man, because ⲟⲩⲁⲧϩⲓ, ancient ⲡⲁⲧⲣⲓ, bald, contains the same consonants as in Phtha, ⲡⲧⲁϩ, r. בָּרָא, *finxit, creavit.*

No. 10 is Venus, the next after Mars, because the Turin papyrus expresses the same Venus by a sparrow-hawk (l. i. 4). Comp. l. ii. 4, xi. 7.

No. 8, the well known *Anb*, Anubis, related with *nubere*, is Mercury; for ϩⲏⲛ, *occultare*, חבא (chaba), *occultavit*, is the root of

Anubis, ancient Hanubis, Mercury, because this planet is commonly invisible, *nuptus*, being too near the sun. The famous astronomer Kepler, as is known, never did see Mercury. For the rest, see the writer's Astron. Æg. p. 98.

No. 6. Since Jupiter, Mars, Venus and Mercury have been represented in Nos. 14, 12, 10 and 8, and since the child Horus signifies the Sun, whilst Thoth bearing the crescent is the Moon, as we shall see directly, everybody understands that the regal figure under consideration must of necessity be Saturn, the resting planet. The latter is expressed by the well known titular name of Busiris, added below that name. Champollion reads the same name "Osortasen," but no such name has been mentioned by the ancients. The fox, called ⲃⲁϣⲟⲩⲣ, sounds *b* and not *o*. The letters *tsn* contain the words ⲧⲱϣ ⲛ̇, *constitutus*, and hence the whole is "*tash n Basur*"—*designatus Busiridis*, i.e. Sapientis, Saturni; for the root of Busiris is בכר (bakar), *cogitare*, *sapere*, and these faculties appertain to the prerogatives of Saturn (Astron. Æg. p. 59). Besides, the king Busiris is mentioned by Diodorus of Sicily; his name occurs on many ancient monuments. Eratosthenes paraphrases his titular name by Thysimares, and, according to him and the Tablet of Abydos, he was the third predecessor of the XVIIIth dynasty, about the year 2000 B.C., 700 years after Menes. In short, this Busiris, the wise one, was an emblem of Saturn, the god of wisdom.

No. 4. It is well known that Horus, the sun (Plate I. l. 1, i.), being represented as a child, signified the sun emerging from the winter solstitial point. The famous allegory of the Egyptians, the pagan Hebrews (Ez. viii. 4), and other nations, sets forth that the sun (Osiris, Thmus, Adonis, etc.) died on the shortest day of the year, but that instantly Horus, the son of the dying king was born for ruling the world instead of his father. Thus this boy (No. 4), adorned with royal insignia and nursed by Anuke, is obviously the sun standing in the winter solstice. The annexed royal name is that of king Horus, the ninth king of the XVIIIth dynasty, born about 1800 B.C. The full name of Horus, copied by Rosellini from different places on the same temple, will be seen on l. viii. 15, 16. The age of our Horus, moreover, is involved in his own name, to-wit: on that day, July 19, 2780 B.C., a conjunction of ♄ and ♂ took place, and this phenomenon returned every thirty Egyptian (vague) years (p. 432). This is the origin of the Egyptian period of 30 years so often mentioned on Egyptian monuments, e.g. on the Rosetta Stone. There king Ptolemæus Epiphanes is called the lord of the Triacontaeteris, because he was born in the year in which that festivity was again celebrated, and the period itself is expressed by the images of the throat, inclusive the uvula, ϫοϫ, the Hebrew חק (chok), and the dish or bowl ϭⲉⲗ, כלי (keli), containing a grain of sand (ⲁⲗ), which give the letters *chg kll*, i.e. חג (chog), ϭⲗⲓⲗ, כליל (kalil), the sacrificial festivity. The cartouch of Horus, then, includes the following words: *Amn mr* (ⲁⲙⲟⲩⲛ ⲙⲉⲣⲉ) *kr* (ⲛⲟⲩⲣⲟ) *nb* (ⲛⲏⲃ) *m* (ⲙ̀) *kll* (ϭⲗⲓⲗ), i.e. The creator's love, Horus, the lord of the jubilee of thirty years.

Finally, No. 1 represents the moon, called Athoth, and ornamented with the crescent, the usual emblem of the moon upon the head of an ibis. The latter, it is true, usually signifies Mercury (see Pl. I. l. i. 3), but the ancients distinguished different Thoths, Mercuries, Hermeses. Manetho (Syncell. p. 40, Paris) mentions three Thoths, and Cicero (N. D. iii. 22) knew of four different Mercuries. Even the *Calendaria rustica* of the Romans and Manilius call the warden of the house of the moon Mercury. (See the writer's Berichtigungen, etc. p. 206.) The notorious image of Mercury bearing wings on its feet and head, signifying celerity, is not the planet Mercury, but the Moon, the quickest of all planets. The proper signification of our Thoth, however, is put beyond question by the distinctive crescent, never appropriate for Mercury.

At present we understand the disposition of the seven planets on our astronomical monument to be in this order:

1	4	6	8	10	12	14
☾ Thoth,	☉ Horus,	♄ Busiris,	☿ Anubis,	♀ Koros,	♂ Phtha,	♃ Amun.

We have now to proceed to the principal question: In what places of the Zodiac stood the seven planets at the beginning of the year in which Horus, the 9th king of the XVIIIth dynasty, the son of Amenophis II., commenced to reign?

No 3, representing a deity nursing the child Horus and the following Anuke (No. 5) is the first sign after the winter solstice, the original sign of ♓ (p. —); for an Egyptian inscription parallels Anuke with Vesta (Letronne, Rer. 344, Ἀνούκει τῇ καὶ

Ἑστία), and Manilius (p. 170) reports that Vesta's house was ♒. See the author's Berichtigungen, etc., p. 205. Consequently our planetary configuration refers to the winter solstice, the natural beginning of the year. Remember that all planetary configurations were observed on a cardinal day preceding the epoch to be fixed astronomically. Concerning the name of this goddess, I spell it: *nk ebol tate kor*, ⲛⲉϫ ⲉⲃⲟⲗ ⲧⲁⲁⲧⲉ ⲕⲟⲩⲣⲟ, the mother of the light of Horus.

No. 5, Anuke, as we have seen, holding Saturn, is the sign preceding the winter solstice; wherefore, at that time Saturn stood in the original sign of ♓, the house of Saturn. The name of Anuke probably refers to the root אנחה (anacha), *gemens*, because the sun was said to die in ♒. Comp. Ezeck. 8, 14.

No. 7 is again Saturn, ornamented with the head of a crocodile, the emblem of Saturn (l. i. 7). His name *Sabak is* ⲥⲟⲩϫⲓ, the crocodile, originally pronounced *sbk*. Consequently ☿, who is never distant from the sun more than 29 degs., was on the same day in ♓ and not in ♒; for since the four deities (Nos. 5, 6, 7, 8) are linked with each other, and because Anubis with Sabacon precede Saturn in ♒, it is evident that Mercury must have occupied the sign Pisces, following Aquarius with Saturn.

No. 13, the god bearing the solar disk, is apparently the sun (l. ix. 11), the warden of the sun's house, Virgo. And this is confirmed by the joined name of this solar deity; for the sparrow-hawk, frequently rendered by the letters *kr* (Gram. Æg. p. 69), gives the word ⲕⲟⲩⲣⲟ, *κύριος*, and the solar disk within a halo (ⲙⲟⲛⲉ, comp. Gram. Æg. Nos. 465, 466), forms the word *κύριος*, the lord of ϩⲉⲣⲙⲁⲛ (a. ⲕⲉⲣⲙⲁⲛ), together ⲁⲣⲁⲕⲗⲗⲉⲙⲱⲛ, Heracleopolis, where Hercules, the sun, was worshipped. Accordingly Jupiter stood on the same day in Virgo, the house of the sun.

The places of the sun in Pisces 0°, of Saturn in Aquarius, of Jupiter in Virgo, of Mercury in Pisces, are in themselves sufficient to determine the year in which king Horus followed his father Amenophis II.; for according to Eratosthenes, who counts from Menes (2780 B.C.) down to Horus 850 years, the latter would have reigned about the year 1830 B.C. According to the Tablet of Abydos, which enumerates for the same time 33 kings, Horus must have ruled about the year 1790 B.C. Now, since Saturn returns after 30 years and Jupiter only after 12 years to the same place of the Zodiac, both planets could not reappear in the same signs but after $12 \times 30 = 360$ years, and consequently there was only one year during the era of the XVIIIth dynasty within which ♄ and ♃ occupied their respective signs, namely, the year 1780 B.C., viz. on the day of the winter solstice.

Let us now see whether the places of the moon, Venus, and Mars, confirm the result or not.

The moon (No. 1) is followed by three sparrowhawk-headed deities (No. 2), which signify three zodiacal segments presided over either by Venus or Mercury, being represented very often by the same sparrow-hawk. According to our Lunar Tables the longitude of the moon on the winter solstitial day –1780 was $1^s\ 17°$; she stood in the middle of Gemini, the house of Venus, and there we find the Decuria of the moon (10°–20°), the Dodecatemorion of ♀ (12½°–15°), and the Moera of ♀ (14th deg.) See the author's Astronomia Æg. Pl. I. Since the Egyptian astronomers, in specifying the place of a planet, disregarded the segments of the Zodiac presided over by the same planet, the Decuria of the moon in ♊ likewise occupied by the moon was not to be mentioned. Consequently the three Hori following the image of the moon signify the house of Venus (♊), the Dodecatemorion of Venus, and the Moera of Venus in ♊ (14°), occupied by the moon.

No. 9, decorated with the insignia of Mars, and called *hm* (ϩⲁⲙ) *ktkt* (σετσοτ) *cæsor*, slaughterer, clearly denotes Mars; namely, his house containing Venus (No. 9). But since Venus's elongation from the sun never amounts to more than 48°, and the houses of Mars ♐ and ♉ being 60 degs. away from the place of the sun between ♒ and ♓, it is evident that the Martial god No. 9 cannot signify the house of Mars, but a zodiacal segment of ♑ not too far from the sun. The computation shows that on the said day Venus stood 39° east of the sun, $10^s\ 9°$ in ♈, the house of Jupiter. The 10th degree of Aries belonged to the Decuria of Venus (0°–10°), the Horion of Venus (8°–14°), the Dodecatemorion of Venns (7½°–10°), and to the Moera of Mars (9°). Zodiacal segments occupied by a planet presiding over the same segments being regularly omitted, it is natural that Venus was joined with a zodiacal segment of Mars. See my Astronomia Ægyp. Pl. I.

Finally, Nos. 11 and 12 represent Mars held by "Manetho," the historical solar deity (l. iv. & v. No. 14). The Tables inform us that ♂ on the said day stood in the 11th sign of the Zodiac, the house of ♂, the original ♉, 24°. This degree belonging to the Decuria and Horion of Mars and to the Moera of the sun, this planet was to be referred to a department of the Sun, because the Egyptians omitted to specify the zodiacal segments belonging to the same planet by which they were occupied. The correctness of this interpretation is confirmed by our monument itself. Mars standing in ♉ and Venus in ♈, they occupied neighboring signs, and therefore our inscription connects the four deities Nos 8, 9, 10 and 11 with each other by means of their arms.

For the rest, the computation of this planetary configuration, though superficial, agrees with the ancient observation. as follows:

YEAR —1780, JAN. 5, 5h., PARIS TIME, WINTER SOLSTICE.

Ancient Reports.		*Computation.*	
☉	9^s 0°	☉	9^s 0°
☾	1 17	☾	1 14
☿	9+	☿	9 19
♀	10 9	♀	10 9
♂	11 23	♂	11 25
♃	3+	♃	3 11
♄	8+	♄	8 4

Such a planetary configuration not occurring twice during a period of 2146 years, the year in which king Horus became king of Egypt is fixed with mathematical certainty. And thus the chimeras of the fanciful Lepsius and other Champollionists, who referred Horus to ten other years, are blown up forever. This important inscription confirms the result that Menes did not enter Egypt before the year 2780 B.C., with which the the first Canicular period and the first Triacontaeteris and the first Apis period began.

Moreover, the birth-year of Horus is likewise fixed by the Egyptian jubilee of 30 years, commencing, as we have seen, in 2780 B.C.; for their renewals happened from 2780 to 1320 B.C. in such years, which, being divided by 30, give the remainder 20; consequently, e.g., in 1820 B.C. Now, since our Horus reigned according to Africanus 38, according to the Armenian Eusebius only 28 years, whilst his father Amenophis ruled 31 years, Horus must have been about 40 years old when his father died. Hence Horus, "the lord of the Triacontaeteris," must have been born in −1820, i.e. 46 years after the departure of the Israelites. In the same way the birth-year of Ptolemæus Epiphanes, "the lord of the Triacontaeteris," is fixed, viz. the year 210 B.C.

By the way, it will interest the reader that, four years ago, an unopened catacomb near Thebes was discovered, which, as the papyrus deposited in the sarcophagus evidenced, contained the well preserved mummy of the wife of the same king Horus, born in 1820 B.C. That papyrus, measuring 40 feet in length, was sold to an American traveler, who transmitted a number of photographs to the Smithsonian Institution, and thence to me. This ancient manuscript, at present nearly 3600 years old, is the oldest now known copy of the Sacred Egyptian records, and the only one of which the age is incontrovertibly fixed. It contains in many places the name of our king Horus and that of the queen Matehemoth (Gratiosa). The historical part of the scroll has been translated and communicated to the assembled members of the American Oriental Society in New York city. See its Proceedings of October, 1877, p. xxvi., and the N.Y. paper "The World," Oct. 26, 1877. I hope to be able to publish the original text of the said papyrus together with my commentary in the next volume of these Transactions. It is, however, to be lamented that this very valuable Egyptian antiquity has for the price of $1600 been sold to the French National Museum in the Louvre, where it will crumble into dust, provided the Champollionists will not abandon their master's theory, and not either publicly or clandestinely appropriate my key, that "regularly each hieroglyph expresses syllabically the consonants contained in its name."

In conclusion, we add the following two planetary configurations, but without discussing the specialties, the latter having been explained in the premises.

3. *Planetary Configuration of Ptolemy Epiphanes, of the year −202, March 24th.*

This astronomical inscription, found in a chapel of the said king at Philæ, and copied by Wilkinson, has been represented in Young's "Hieroglyphics," Pl. 66.

No. 1, on the left hand side, is the familiar Phtha, Mars, united with the Sun-god (No. 2); wherefore ♂ stood in ♍, the house of the sun.

No. 3: Mak, Saturn, combined with with the Decuria of Mercury of the same sign ♍, is evidence that ♄ stood between 10° and 20° in ♍.

No. 5: Lunus, followed by Neith (No. 6), the warden of Sagittarius, the house of Mars, occupies ♐.

No. 7: the Sun-god, held by Venus (No. 8), represents the sun on the vernal equinoctial day, i.e. in 0^s 0° 0′; consequently the observation of the seven planets refers to March 24th, then the vernal equinox.

No. 9: the ram-headed deity, the readily recognized Jupiter Ammon, is referred to the house of Mercury, Libra (No. 10).

No. 11: Venus, the well known sparrowhawk-headed god, is followed by the goddess signifying Mercury (Pl. I. l. vi. 1 & 1, iii. 2), because Venus stood in the Horion and Dodecatemorion of Mercury in the sign of Taurus.

No. 13, finally, being damaged, must, of course, express the resting planet Mercury, and the two conjoined figures (14 and 13) are the smaller segments in Taurus which were occupied by Mercury.

The computation of this planetary configuration agrees with the reported places of the planets. Apart from all other planets, the positions of the sun in ♊ 0°, of the moon in ♎ 20°–30°, and of Mars in the house of the sun (♍), put beyond question that the observation was made on the vernal equinoctial day of the year _202.

The Egyptians having been in the habit of fixing historical events by representing the planetary configuration on a cardinal day next preceding, it follows that Ptolemæus Philopator died and Epiphanes followed between the vernal equinox and summer solstice of the year _202.

As far as the other deities below the principal rows are concerned, they signify the variety of the zodiacal stars following each planet, as is the case with the figures on the sarcophagi of Osimandyas, Ramses and Takelophis, the monolith of Amos, and the like.

4. Cæsarion's Nativity.

The astronomical inscription under consideration, preserved on a temple-wall of Dendera, has been represented by Rosellini in his "Monumenti del Egitto e della Nubia," vol. iv., Pl. cccxlix. The astronomical figures being nearly the same as explained in the premises, no extensive commentary will be needed for understanding the single planetary and zodiacal deities, and fixing the day and the year of the observation.

The principal figure, offering an incense sacrifice in front of the row of the astronomical figures, is a juvenile king called Neocæsaros, the reported son of Cleopatra and C. J. Cæsar.

The facing deity is *kr*, expressed by the sparrow-hawk, the sun (Pl. I. l. i. No. 1); consequently, ⲕⲟⲩⲣⲟ (Cyrus), the sun. The following goddess represents the figure of Isis, the man, the warden of the house of the moon, the original ♌ (Plate I. iii. 1). This conjunction of the sun with Isis argues that our planetary configuration was observed on the cardinal day of the summer solstice.

Behind Cæsarion and opposite to the sun appears Isis (☽), and thus it was signified that on the same day the moon stood in the opposite sign (♓). Since the moon during a period of 19 years is only once full on the summer solstitial day, the year in which Cæsarion was born, viz. 45 B.C., is already fixed.

The next planet, the sparrowhawk-headed "Horus," the Greek χόρος, the Apollino of the Romans, Mercury, is followed by Osiris (☉), likewise expressed by the sparrow-hawk (Pl. I. l. viii. 2). Near the sun in ♌ 30°, being the Decuria of the ☉ (20°–30°), the longitude of ☿ on the said day is determined.

The next planet, again expressed by the sparrowhawk-headed Horus, is Venus (Pl. I. l. 1, No. 4); she is followed by the well known Isis-Venus, and, there being a Horion of Venus near the sun in ♌, this planet appeared between 13°–18° in Leo.

The other part of the row declares, in the first place, that the moon stood then in the Dodecatemorion of Mercury in ♓, i.e. 25° –27½°, or in the Moera of ☿ (♓ 20°), which makes no difference concerning the day.

The sequent figure of the ☉, followed by the Sun-god, proves that this planet appeared not only in the house of the moon (♌), but also in that of the ☉ (♍), as is the case on the day of the summer solstice.

The next group conjoins the familiar Phtha (♑, Pl. I. l. viii. No. 12) with Saturn (ib. l. ix. No. 7); therefore Mars must have been in a department of Saturn. In short, on that solstitial day in which the moon stood in opposition with the sun, Mars appeared in his house (♉), his Decuria 20°–30°, his Horion ·20°–28°, and in the Dodecatemorion of ♄ 25°–30°. The following goddess, referring to Mercury, probably points to the Moera of ☿ (♉, 25°). Since, then, the Egyptians omitted to regard the segments of the Zodiac belonging to the planet which occupied them, as we have so often seen, they had no occasion to mention that Mars stood in the Sign, Decuria, or Horion of his own, but in the Dodecatemorion of ♄ and in the Moera of ☿.

It is for the same reason that Saturn and Jupiter are not mentioned at all on our astronomical monuments; they must have been in their own houses, not modifying the imaginary influences of the respective planets.

The following is, then, the nativity of Cæsarion as apeared on the summer solstitial day June 25th, in -45, compared with our superficial computations:

Ancient Reports.		*Computation.*
☉ 3^s $30° = 4^s$ $0°$	....	☉ 4^s $0°$
☾ 9^s +	....	☾ 9^s $26°$
☿ 2^s $20° - 30°$	....	☿ 2^s $26°$
♀ 2^s $13° - 18°$	....	♀ 2^s $16°$
♂ 11^s $25° - 30°$	....	♂ 11^s $20°$
♃ 7^s +	....	♃ 7^s $19°$
♄ 8^s +	....	♄ 8^s $19°$

This new astronomical monument of the Egyptians is no trifle. It confirms, on the contrary, the great discovery of the present century, that the whole Historical Canon of Ptolemy is wrong; and that Petavius, following the latter, with all his satellites, who from 1627 down to this day, *bona fide* copied Petavius, referred all events of Roman, Greek and Persian histories, etc., to wrong years.

According to Ptolemy and Petavius, C. J. Cæsar crossed the frozen Rubicon and marched against Rome in the year -50 B.C. During the same month, however, a total eclipse of the sun and a total eclipse of the moon happened, as the ancients report, which was not the case in -50, but -47 only. Consequently

Cons. Marcellus and Lentullus and the first year of Cæsar belonged to –47 and not to –50. See these Transactions, vol. iii. p. 447.

Further, in the following year Cæsar went over to Epirus against Pompejus, and one year later, on the 28th of June, the battle of Pharsalus took place, according to Petavius in –48. In the same year, Aug. 18, Pompejus was killed in Egypt, and two days later (Aug. 20) Cæsar arrived in Egypt. In the following year, according to Petavius in –47, Cæsar captured Alexandria on Feb. 8, and remained there nine months. In the next year, –46, April 21, Cæsar left Egypt, and a short time after his departure, as Dio. xlii. 44, says, Cæsarion was born; our planetary configuration, to the contrary, referring, as usual, to the cardinal day preceding the birth-day of Cæsarion, puts the latter in –45. Thus it is mathematically demonstrated that Petavius and Ptolemy have antedated Cæsar's crossing the Rubicon at least one year, which is confirmed by the two eclipses in 47 B.C. Therefore, the consuls of this year and all their predecessors, and all the events of Roman history since the foundation of Rome, have to come down by one year. Rome originated in 752 and not in 753 B.C.

Moreover, since Cæsar ruled six years and was six times Dictator, he must have died in –41 and not in –43, and since in the same year the Olympian games were celebrated, it is obvious that the Olympiads commenced two years later than Petavius fancied, and that consequently all events of Grecian history happened respectively two or one year later than Petavius imposed upon the world. All these chronological particulars have been discussed *in extenso* in these Transactions, vol. iii. p. 401, and they are now mathematically confirmed by Cæsarion's Nativity.

Notes on the Mineralogy of Missouri.

By Alexander V. Leonhard.

This article contains:

I. A descriptive catalogue of the mineral species of Missouri.

II. A list of the important localities of minerals in Missouri.

It forms the beginning of a series of publications on the mineralogy of Missouri, which I am preparing at present.

I may remark that all the species, enumerated in the catalogue, are nicely represented in the "Collection of Missouri Minerals" which forms a part of the mineral collections of the Mining Department of Washington University.

A. V. L.

Washington University, St. Louis, Missouri, May, 1882.

I. Catalogue of the Mineral Species of Missouri.

COPPER.

Native Copper.

At *Stanton Copper Mines*, *Franklin Co.*, in massive pieces, coated with Cuprite and Malachite; in wire-like aggregations on Cuprite; also pseudomorph after Chalcotrichite.

At *Hinch Copper Mine*, and at *Blending Hill Mine*, *Crawford Co.*, in small scales with Cuprite. Rare.

Chalcocite.

At *St. Genevieve Copper Mines*, *St. Genevieve Co.*, massive with other copper ores.

Covellite.

At *St. Genevieve Copper Mines*, in bluish-black earthy masses with Chalcopyrite.

Chalcopyrite.

At *St. Genevieve Copper Mines;* at *Stanton Copper Mines*, *Franklin Co.;* at *Walden Mine*, *Washington Co.;* at *Copper Hill*, *Hinch Copper Mine*, and *Blending Hill Mine*, *Crawford Co.;* at *Collins Mine*, *Cooper Co.;* at *Old Circular Mine*, *Cole Co.;* massive, associated with other copper ores; often forming a breccia by cementing angular pieces of chert.

At *Mine La Motte*, *Madison Co.;* at *Old Copper Mines*, *Madison Co.;* at *St. Joe Mines*, *St. Francis Co.* In small quantities with Pyrite and Linnæite in Galenite.

Bornite.

At *St. Genevieve Copper Mines.* Massive with other copper ores.

Cuprite.

At *Stanton Copper Mine, Franklin Co.* In acicular crystals (Chalcotrichite).

At *St. Genevieve Copper Mines.* Massive, of brown-red color ("Tile Ore.")

Melaconite.

At *St. Genevieve Copper Mines.* Massive, black, earthy up to ½ an inch thick, on Chalcopyrite.

Malachite.

At *St. Genevieve Copper Mines.* Acicular crystals, up to $\frac{1}{6}$ of an inch long; in bands of columnar fibrous structure, in Limonite or with Cuprite. Also mixed with clay, in light green, earthy, porous masses.

At all other copper mines in the State, vide Chalcopyrite.

At *Scotia Iron Bank, Crawford Co.*, in globular aggregations, up to $\frac{1}{3}$ of an inch in diameter, in drusy cavities of Specular Iron Ore.

At *Collins Mine, Cooper Co.*, and at *Abbott Bank, Miller Co.*, in drusy cavities of Limonite.

In *Wright* and *Ozark Cos.*, disseminated through Calcite.

Also in many localities, in small particles disseminated in limestone.

Azurite.

At *Scotia Iron Bank, Crawford Co.*, in soft Red Hematite, as a light blue lining of irregular cavities, or as a dark blue filling of crevices, with columnar fibrous structure.

At *St. Genevieve Copper Mines*, in small crystals on Limonite, but mostly massive.

Also at all other copper mines of Missouri, vide Chalcopyrite.

Chalcanthite.

At *St. Genevieve Copper Mines*, as light blue coating on Covellite.

LEAD.

Galenite.

In numerous localities, which may be grouped in three districts:

1. In *South-west Missouri*—at *Granby, Newton Co.;* at *Joplin* and *Oronogo, Jasper Co.* Crystals in cubes, octahedrons (up to 4-inch side-length) or dodecahedrons, but mostly in combinations of these forms. Compact crystalline masses, with Sphalerite or Calamine in Dolomite, chert, or clay. In Joplin, sometimes impregnated by bitumen. Contains about 1 oz. of Silver per ton.

2. In *Central Missouri* in many places, principally in *Morgan Co., Miller Co.* and *Cole Co.*—in cubes, with a side-length up to 6 inches, generally coated with Cerussite, and in crystalline masses weighing up to 5,000 lbs. and more, embedded in red clay, or in altered magnesian limestone, or with Barite. At *Sampson's Coal Mine, Moniteau Co.*, filling fissures in cannel-coal. Contains only a small trace of Silver.

3. In *South-east Missouri*—at *Mine La Motte, Madison Co.*, and at *St. Joe, St. Francis Co.*, with Linnæite and Chalcopyrite in limestone; at *Einstein Silver Mine, Madison Co.*, with Sphalerite and Pyrite in Quartz; at *Valle Mines, Jefferson Co.*, with Sphalerite, Calamine, and Smithsonite; in *Madison Co.*, in small veins in Porphyry; in numerous other localities, generally with Barite or in clay or sand. Contains 1–4 ozs. Silver per ton; a fine-grained variety in Madison Co. contains 6–7 ozs., and the Galenite at Einstein Silver Mine contains 40–110 ozs. per ton.

MINIUM.

At *Virginia Mines, Franklin Co.*, massive with Cerussite, formerly found in large quantities.

CERUSSITE.

At *Valle Mines, Jefferson Co.*, beautiful crystals lining the walls of cavities in Galenite.

At *Granby Mines, Newton Co.*, in amorphous, porous or compact pieces of earthy appearance and white or reddish color. A gray ashy variety surrounds unaltered Galenite or fills cubical cavities. Cavities in massive Cerussite, formerly occupied by crytsals of Galenite, are often coated by crystalline C., from which gray to black translucent crystals of C. project towards the interior of the cavity.

At *Oronogo, Jasper Co.*, in amorphous porous pieces with drusy aggregations of well developed crystals, sometimes over $\frac{1}{4}$ of an inch long. They often show a combination of one brachydome, which is terminated at both ends by the faces of the pyramide and of the prism.

At *Mine-à-Burton* and *Cove Mines, Franklin Co.*; at *Mine La Motte, Madison Co.*; and at *Palmer Mines, Jefferson Co.*, massive, and in well developed crystals.

At *Boaz Mine, Cole Co.*, massive. In most of the lead mines of the State as a gray coating on Galenite.

PYROMORPHITE.

At *Granby Mines, Newton Co.*, in small crystals in cavities of amorphous Cerussite; in loose, rounded pieces from pea to nut-size, yellowish-green and earthy on the outside, compact and of lighter color in the interior; mostly as shaly greenish coating on Cerussite.

ANGLESITE.

At *Cove Mines, Franklin Co.*, in fine crystals, about $\frac{1}{3}$ of an inch long and $\frac{1}{6}$ of an inch thick, on Galenite crystals whose surface is corroded and partially coated with Cerussite. They show a combination of the macropinacoid, the one-half macrodome, the prism, the brachypyramide 2, and the brachydome; or of the brachypyramide 2, with the brachydome. The crystals are striated along the faces of the domes, and of a dark gray color, due to a thin coating of Cerussite. When treated with dilute hydrochloric acid, the coating dissolves and leaves the Anglesite crystal milk-white and with smooth faces.

At *Valle Mines, Jefferson Co.;* at *Hopewell Mines* and *Mine-à-Burton, Franklin Co.;* at *Mine La Motte;* and at *Oronogo, Jasper Co.*, crystallized in cavities of Galenite or of Cerussite.

PLUMBOGUMMITE.

At *Palmer Mines, Jefferson Co.*, and at *Mine La Motte, Madison Co.*, in small greenish globules, of waxy luster, and of less than pin-head size, with crystals of Cerussite on Galenite, whose surface is corroded.

ZINC.

SPHALERITE.

At *Joplin, Oronogo*, and *Webb City, Jasper Co.*, reddish-brown crystals, sometimes 1 inch in diameter, in silicious clay, showing combinations of dodecahedron with cube and hemi-trapezohedron, with curved, convex faces; also in small bright red crystals. Mostly massive, or coarse crystalline, of dark brown color; sometimes green, greenish-yellow or red. Rarely in black or bluish-black pieces with metallic lustre, resembling Galenite, which, by analysis of R. Chauvenet, proved to be pure S., with but traces of lead and iron. A fine-grained variety forms part of a breccia, in which pieces of chert are cemented by siliceous matter, Sphalerite and Pyrite; often intimately mixed with Galenite.

At *Granby Mines, Newton Co.*, in coarse crystalline masses, with Calamine and Galenite. Crystals are frequently coated by Greenockite. The coarse crystalline variety encloses bands, up to 1 inch thick, of a fine-grained or granular variety, with small bright red crystals of adamantine lustre.

At *Mount Hope Mine, Franklin Co.*, massive with Smithsonite.

At *Darby's Mine, Franklin Co.*, mixed with Pyrite.

In *Moniteau Co.*, crystals and sheets in cannel-coal.

In *St. Louis Co.*, in crystalline masses, of brown or black color, in cavities of limestone.

At *Sugar Creek, Buchanan Co.; Holden, Johnson Co.; Grand River, Henry Co.*, in the interior of Clay Iron Ore concretions in slate of the coal formation.

At *Nodaway Co.*, enclosed in crystalline Calcite.

SMITHSONITE.

At *Granby Mines, Newton Co.*, aggregations of milky-white crystals, in the form of flat rhombohedrons, on Calamine; in the Hardshaft in hollow stalactitic forms, covered by small transparent crystals of Smithsonite; massive, usually grayish-brown, and of fine-grained structure; occasionally dense and of light yellow color.

In *Dade Co.*, in masses of light grass-green or of yellowish-gray color, fine-grained, and porous, in botryoidal forms.

At *Collins Mine, Cooper Co.*, massive, mixed with Limonite.

At *Perry Mine* and *Birch Mine, St. François Co.*, in small quantity with Sphalerite.

At *Valle Mines, Jefferson Co.*, massive, with Calamine and Sphalerite.

At *Mt. Hope Mine, Franklin Co.*, massive.

At *Eureka Mine, Cole Co.*, as brown coating on broken chert.

HYDROZINCITE.

At *Granby Mines, Newton Co.*, and at *Valle Mines, Jefferson Co.*, as white amorphous coating on crystalline Calamine.

CALAMINE.

At *Granby Mines, Newton Co.*, crystals thin lamellar, about $\frac{1}{10}$ of an inch long, perfectly transparent and colorless, or dark green and opaque. They frequently show a combination of two different prisms, the macrodiagonal faces, one macrodome and one brachydome. They are mostly arranged in radiated globular forms or in botryoidal groups on massive Calamine, or on Galenite. Compact Calamine forms layers up to 8 feet thick; it is opaque, yellow or reddish-brown, and of fine-grained structure, and contains numerous cavities with crystals of Calamine or of Dolomite. Also in stalactitic forms.

At *Valley Mines, Jefferson Co.*, at *Perry Mine* and *Bisch Mine, St. François Co.*. and in many other mines of South-east Missouri, it occurs massive. usually with Smithsonite, Sphalerite, and Galenite.

BURATITE.

At *Granby Mines, Newton Co.*, in globular aggregations of apple-green color, sometimes $\frac{1}{2}$ of an inch in diameter, but usually smaller, resting on crystals of Dolomite or of Calamine. Rare.

CADMIUM.

GREENOCKITE.

At *Granby Mines, Newton Co.*, frequently as coating on Sphalerite, of earthy appearance and of bright yellow, yellowish-green or green color. Rarely in small crystals in fissures of Sphalerite.

TITANIUM.

MENACCANITE (?).

In *St. François Co.* and in *Madison Co.*, in loose compact pieces up to fist-size.

COBALT AND NICKEL.

MILLERITE.

At *St. Louis*, in cavities of the St. Louis limsetone. In dark greenish-yellow hair-like aggregations, irregularly interwoven and looking like spider-web, laying loosely on crystals of Dolomite, Fluorite or Calcite, sometimes forming bunches that nearly fill the whole cavity. Or in very thin, straight, needle-like prisms of high metallic lustre, up to 6 inches long, radiating from points at the wall of the cavity. Also in pointed spear-like forms, consisting of parallel long thin prisms adhering toeach other. These "spears" have been observed as large as 2 inches long and $\frac{1}{4}$ of an inch thick; they sometimes transverse crystals of Calcite or of Fluorite. Calcite frequently encloses Millerite in considerable quantity. Often as dark green coating, of small fibres and of earthy appearance, on the limestone.

LINNÆITE.

At *Mine La Motte, Madison Co.*, and at *St. Joe, St. François Co.*, the Nickel-Linnæite or Siegenite occurs massive with Pyrite and Chalcopyrite in Galenite. Rarely in small crystals.

ANNABERGITE(?).

At *Mine La Motte* and at *St. Joe Mines*, in small globular pieces, of about pin-head size, and of apple-green color, on Chalcopyrite or on Galenite. Rare.

ASBOLITE.

At *Mine La Motte* and at *Old Copper Mines, Madison Co.*, in black, earthy masses, containing 5 per cent. and more of Nickel.

WOLFRAM.

TUNGSTITE.

In *St. François Co.*, in yellowish-green earthy masses on Quartz. Rare.

WOLFRAMITE.

Near *Einstein Silver Mine, Madison Co.*, and in several places in *St. François Co* , massive and in long prismatic crystals in Quartz.

IRON.

METEORIC IRON.

Has been found in *Bates Co.* and in *Howard Co.*

PYRITE.

At *Joplin, Jasper Co.*, in crystals and in stalactitic forms, sometimes 6 inches long, with Galenite.

At *Mine La Motte* and *St Joe*, with Galenite, Linnæite, and Chalcopyrite.

At *St. Louis*, in minute crystals on thin needles of Millerite.

At *Pettis Co.*, fossils in the coal-shales are composed of Pyrite.

At numerous other localities, especially throughout the coal and slate deposits of the Coal-Measures, and disseminated in limestone.

MARCASITE.

At *Joplin, Jasper Co.*, sometimes forming a compact coating, up to ¼ of an inch thick, covered with well developed crystals, over large crystals of Galenite.

In *St. Louis Co.*, crystals in Dolomite.

In many other localities, mostly in massive pieces, often changed to Limonite on the outside.

PYRRHOTITE.

At *Mine La Motte*, massive, with Galenite, containing Nickel and Cobalt.

MAGNETITE.

In *St. François Co.*, in well developed octohedrons, of sometimes ½ of an inch side-length, loose in sand.

In *Iron Co.*, at *Shephard's Mt.*, in small crystals on Specular Iron Ore.

At *Pilot Knob*, microscopic crystals in Serpentine.

HEMATITE *var.* SPECULAR IRON ORE.

At *Iron Mountain*, *St. François Co.*, massive, steel-gray to dark gray, semi-crystalline to coarse crystalline, submetallic to metallic lustre. Always more or less magnetic, showing polar magnetism, containing 2 to 5 per cent. of protoxyd of iron; with 65-68 per cent. of metallic iron. At *Pilot Knob*, *Iron Co.*, massive, steel-gray with a strong tinge of sky-blue; lustre silky to submetallic; fracture subconchoidal; not magnetic. The best ore contains 5-13 per cent. of Silica, which percentage increases in the inferior grades of the ore. Also forming a conglomerate by cementing crystals and pieces of transparent Quartz.

At *Scotia Banks*, *Crawford Co.*, in small, highly splendent crystals, covering the walls of drusy cavities in the Specular Ore. They are often tarnished, displaying all the colors of the rainbow. Also in reticulated forms, enclosing transparent Quartz and dark yellow Jasper.

At *Simmons Mountain*, *Dent Co.*, crystals (flat rhombodedrons) seated on Quartz in drusy cavities of the Specular Ore.

At *Smith Bank*, *Phelps Co.*, in hollow stalactitic forms, covered with splendent crystals.

HEMATITE *var.* RED HEMATITE.

In *Callaway Co.*—At *Knight's Bank*, massive, of light red color, hardness = 6, associated with Siderite. At *New Bloomfield*, bluish-gray or dark red, often thinly stratified, and enclosing fossils. At *Henderson Bank*, an oolithic variety.

In many localities, principally in *Franklin Co.*, *Phelps Co.*, *Crawford Co.*, and *Dent Co.*, mostly in soft (H = 2-3) earthy masses, sometimes with silky lustre, often greasy to the touch; also in botryoidal forms.

GOETHITE.

At *Scotia Banks*, *Crawford Co.*, in thin long crystals, on crystals of Amethyst, partially enclosed in the latter.

In *Adair Co.*, in small crystals on Calcite crystals. Rare.

LIMONITE.

In numerous deposits in the south-eastern and central parts of the State, very often with stalactitic structure. In some places, f.i. at *Moselle*, *Franklin Co.*, as so-called "kidney-ore." These "kidneys" are rounded forms, sometimes several inches in diameter, hollow inside, the shell being of hard dark brown Limonite, up to ½ of an inch thick, covered by yellow ochre.

SIDERITE.

In *Phelps Co.*, at *Meramec Bank*, and near *Rolla*, in specks and seams in Red Hematite, and in ferruginous limestone.

In *Callaway Co.*, at *Knight's Bank*, in considerable quantity, with Red Hematite.

In the Coal-measures of the State, especially in *Carroll Co.*, *Johnson Co.*, *Henry Co.*, *Vernon Co.*, and *Barton Co.*, as Clay Iron Ore, of brown or brownish black color and earthy appearance, mostly in lenticular masses, 1–20 inches thick.

MELANTERITE.

As white efflorescence on old dumps and in old passages of coal mines; and in the water of many springs.

MANGANESE.

PSILOMELANE.

In *Bollinger Co.*, massive, often in stalactitic forms, with Limonite.

HAUSMANNITE.

In *Dent Co.*, in massive pieces.

WAD.

In *Bollinger Co.*, and at *Stephens Coal Bank, Cooper Co.*

At *Mine La Motte* and *Old Copper Mines, Madison Co.*, in black earthy masses, containing Nickel, Cobalt and Copper.

Rem.—Manganese Ore, occurs in *Iron Co.*, on Cuthbertson tract (as sesquioxyd, perhaps with binoxyd) and on Marble's land (as protoxyd), mixed with more or less sesquioxyd of iron.

ALUMINIUM.

PICKINGERITE.

At *McCarrow's Coal Bank, Barton Co.*, observed by C. J. Norwood, as white efflorescence, with silky lustre, on sandy shales of the Coal-measures. In bands, ½–2½ inches thick. It contains (analysis of R. Chauvenet):

Sulphuric Acid	35.77
Alumina	15.55
Magnesia	2.92
Water	44 64
	98.88

LAZULITE.

At *Pilot Knob, Iron Co.*, microscopic crystals of deep blue color, in Serpentine. (Observed by A. V. Leonhard.)

MAGNESIUM.

DOLOMITE.

In *St. Louis*, in cavities of the limestone. Very frequently as a compact lining of these cavities, of light pink color, wholly covered by Dolomite crystals of the same color, with strong pearly lustre, in the usual form of the rhombohedron, with curved or distorted faces. Single well developed crystals are often wholly or partially enclosed in Calcite crystals, or embedded in aggregations of Millerite crystals.

At *Granby, Newton Co.*, it forms the principal "gangue" in the Lead and Zinc Ore deposits. Mostly in coarse crystalline bands, in dolomitic limestone, associated with the ores, and covered with Dolomite crystals. Color white, yellow, or yellowish-brown.

In *Cedar Co.*, in coarse crystalline bands of drab or light pink color, in limestone.

ANKERITE.

In *Phelps Co.*, in bands in Red Hematite.

EPSOMITE.

In the water of several mineral springs, especially in *Bates Co.*

CALCIUM.

CALCITE.

In *St. Louis*, in cavities of the limestone, in well developed crystals, up to 6 inches long and about 2 inches thick at the base, colorless to light yellow, transparent to translucent. They often show a combination of the prism, one or two different scalenohedrons, terminated (often on both ends) by the negative ½ rhombohedron. Often the prism predominates, terminated by faces of two different rhombohedrons. Also in many other combinations. They sometimes enclose Millerite and Dolomite crystals.

In *Jasper Co.*, on *Spring River*, in a violet colored variety.

At *Granby*, *Newton Co.*, in crystalline masses, sometimes enclosing seams and crystals of Galenite, and in scalenohedral crystals up to 6 inches long.

In *Washington Co.*, dark yellow crystals, several inches long, with globular aggregations of Barite, on Galenite.

In very many other localities, in crystals or crystalline masses, or in stalactitic forms, or as an incrustation.

ARAGONITE.

In *Jasper Co.*, in dark reddish-brown columnar aggregations.

Near *Lexington*, *Lafayette Co.*, in crystals.

In *Washington Co.*, *Franklin Co.*, and in many other localities.

GYPSUM.

In *St. Louis*, in cavities of the limestone in perfectly transparent crystals, of strong vitreous lustre, sometimes 1½ inches long and ½ of an inch broad. They show combinations of the clino-pinacoid with the faces of several prisms, terminated by faces the negative and positive hemi-pyramide. The crystals, often lamellar by a large development of the faces of the clino-pinacoid, are grouped together parallel to each other, and seated on crystalline, snowy-white, corroded masses of Gypsum.

Near *Salisbury*, *Chariton Co.*; *Atlanta*, *Macon Co.*: *Knob Noster*, *Johnson Co.*; *Lexington*, *Lafayette Co.*; *Grundy Co.*, and *Carroll Co.*, crystals of Selenite well developed, embedded in the clay and shales of the Coal-measures. These crystals are translucent to transparent, of pearly or subvitrious lustre. They show the combination of the prism, both hemi-pyramides, and the clino-pinacoid, and are often about 1½ inches long, ¾ of an inch broad, and ½ of an inch thick between the faces of the pinacoid.

ANHYDRITE.

In *St. Louis*, in cavities of the limestone, in rounded aggregations, of radiated fibrous structure, sky-blue color, and silky lustre, partially embedded in Gypsum.

In *Franklin Co.*, in aggregations of light pink color and radiating columnar structure.

FLUORITE.

In *St. Louis*, in cavities of the limestone, in transparent cubic crystals of light honey-yellow color, of sometimes 1½ inches side-length, rarely enclosing crystalline aggregations of Millerite.

In *Iron Co.*, in cavities of the porphyry, in small crystals of amethyst color.

At *Einstein Silver Mine*, *Madison Co.*

APATITE.

At *Iron Mountain*, *St. François Co.*, in Specular Iron Ore. In crystals of light pink color, of earthy appearance, with a hardness less than 5; evidently partially decomposed. Also in compact flesh-colored masses.

BARIUM AND STRONTIUM.

BARITE.

In *Morgan Co.* and *Cole Co.*, massive and crystallized. Crystals often perfectly transparent, up to 4 inches long, showing a combination of the brachy-pinacoid, the brachydome, the prism, and a small development of the macrodome. Also in large tabular crystals, translucent and of light bluish color, showing the faces of the brachy-pinacoid and the macrodome. The latter variety contains Strontium, being perhaps Barito-celestite.

In the *South-eastern part of the State* in many localities, especially in *Jefferson Co.* and *Washington Co.*, massive, of white, yellow or light brown color, often coarsely laminated. Crystals, lamellar and opaque, on massive Barite. In most of the Lead mines of that region associated with Galenite; sometimes forming globular snowy-white crystalline aggregations on crystals of Galenite.

In *St. Louis*, in cavities of the limestone, in snowy-white, rounded incrustations on Calcite crystals or on Millerite.

In *Jackson Co.*, massive and in opaque crystals of flesh-color.

WITHERITE.

Near *Potosi*, *Washington Co.*, massive, in botryoidal forms. Rare.

Rem —It has been proved by spectral analysis that most of the dolomitic limestone of South-east Missouri, especially the so-called third magnesian limestone, contain traces of Strontium.

POTASSIUM AND SODIUM.

NITRE.

In *Ozark Co.*, as efflorescence on sandstone (observed by Shumard.)

At *Portland*, *Callaway Co.;* in *Pulaski Co.*, and *Maries Co.*, in the clay of caves.

HALITE.

In incrustations and in the water of many springs, especially in *Saline Co.* and *Howard Co.*

SILICA.

QUARTZ.

At *Scotia Iron Banks, Crawford Co.*, rock crystals, sometimes several inches long and often enclosing wax-yellow Jasper, in cavities of Specular Iron Ore. Rarely Amethyst crystals on Jasper.

In *South-east Missouri*, in transparent grains, sometimes of smoky Quartz, in granites, and in porphyries. Amethyst crystals in quartz veins, traversing the granite, in *Madison Co.;* Banded Agate in porphyry in *Iron Co.;* Transparent Quartz with Specular Ore in conglomerates at *Pilot Knob, Iron Co.* Large quantities of Quartz geodes, mammillary and drusy Quartz on the surface of dolomitic limestone hills.

FELDSPAR.

In *South-east Missouri*, in the granites and porphyries. Flesh-colored Orthoclase in the granite of *Brown's Quarry* and in other localities; white or pink crystals, $\frac{1}{6}$–$\frac{1}{4}$ of an inch long, in porphyry, probably Oligoclase.

MICA.

Near *Einstein Silver Mine, Madison Co.*, Muscovite with Quartz. In the granites of S.E. Missouri Mica is but rarely found.

In the *sandstone of the Coal-measures*, abundant in minute scales.

HORNBLENDE.

In *South-east Missouri*, especially *Madison Co.*, in syenitic granite and in Dolerite. Acicular crystals of Actinolite in Quartzite.

ASBESTOS.

In *Madison Co.*, in long silky fibres, in small pockets between layers of Dolerite.

EPIDOTE.

Massive, or with fibrous structure, in the granites and porphyries of *S.E. Missouri*, especially *Iron Co.*, *Madison Co.*, and *St. François Co.*

SERPENTINE.

In the porphyry region of *S.W. Missouri*, especially in *Iron Co.* and *Madison Co.*, massive, of light grass-green color, hardness = 2–3, with greasy or waxy lustre. Mostly enclosing microscopic crystals of Magnetite.

CHLORITE.

In *S.E. Missouri*, in granites of *Madison Co.;* also impregnating the groundmass of some of the porphyries.

GARNET.

Common Garnet in "Drift boulders" in *Northern Missouri.*

SULPHUR.

NATIVE SULPHUR.

In *St. Louis Co*, in dumps of coal mines, in small crystals, or forming incrustations. (Observed by G. Hambach.) Rare.

CARBON.

BITUMEN.

At *Joplin, Jasper Co.*, in cavities and crevices of subcarboniferous limestone in a plastic or semi-fluid state; also impregnating Galenite and Sphalerite, which then show a darker color and emit a bituminous odor when broken or rubbed.

In the *sandstone* of the *coal-measures*, either in a viscid state in cavities, or impregnating large portions of the rock.

MINERAL COAL.

Bituminous Coal, abundant in the coal-measures of the State, usually with some Pyrite. *Cannel Coal*, in large pockets, in *Lincoln Co.*, *Callaway Co.*, *Cole Co.*, *Moniteau Co.*, and several other counties. It often encloses Calcite; in some places, especially in Moniteau Co., it also contains Sphalerite and Galenite.

Mineral Charcoal, in thin layers and in pieces in bituminous coal at *Clear Fork* and near *Warrensburg, Johnson Co.* (Observed by G. C. Broadhead.)

II. List of prominent localities of Minerals in Missouri.

The names of minerals, obtainable in good specimens, are distinguished by italics; one exclamation mark (!) is added when the specimens are remarkably good, or two of these marks (!!) when the specimens are quite unique.

BARTON CO. — *Pickeringite* (!).

BENTON CO. — *Limonite.*

BOLLINGER CO. — *Limonite*, Bog Manganese, Psilomelane.

BUFFALO MINES, Morgan Co. — *Galenite* (!).

CALLAWAY CO. — *Red Hematite* (!), *Clay Iron Ore.*

COLE CO. — *Barite* (!).

CHARITON CO. — *Selenite.*

COLLINS MINE, Cooper Co. — *Malachite*, Azurite, Chalcopyrite, Smithsonite, Galenite, Sphalerite, Limonite.

COVE MINES, Franklin Co. — *Galenite. Cerussite, Anglesite* (!), Barite.

DADE CO. — *Smithsonite.*

EUREKA MINES, Cole Co. — *Galenite*. Smithsonite.

EINSTEIN SILVER MINE, Madison Co. — Galenite, *Sphalerite*, Wolframite, Pyrite, Quartz. Muscovite, Actinolite, Fluorite.

GRANBY MINES, Newton Co. — *Galenite* (!), *Cerussite, Pyromorphite, Calamine* (!), *Greenockite* (!), *Sphalerite* (!), *Smithsonite, Hydrozincite, Buratite*, Dolomite, Calcite.

HUMES' MILL, Morgan Co. — *Barite* (!).

IRON MOUNTAIN, St. François Co. — *Specular Iron Ore, Apatite.*

JOPLIN MINES, Jasper Co. — *Galenite* (!), *Sphalerite* (!), *Pyrite.* Cerussite, Bitumen. *Marcasite.*

MADISON Co. — Menaccanite (?), Quartz, Agate, Hornblende. Serpentine, Asbestos, Chlorite, Epidote, Feldspar.

MINE-À-BURTON, Franklin Co. — *Galenite, Cerussite, Anglesite.*

MINE LA MOTTE, Madison Co. — *Galenite* (!), *Siegenite*, Cerussite. Anglesite, Pyrrhotite, Earthy Cobalt, Bog Manganese, Plumbogummite, Annabergite (?), Chalcopyrite.

MOSELLE, Franklin Co. — *Limonite* (!).

MOUNT HOPE MINE, Franklin Co. — Galenite, Sphalerite, Calamine, Smithsonite.

ORONOGO, Jasper Co. — *Galenite, Sphalerite, Cerussite, Smithsonite.* Anglesite.

PALMER MINES, Jefferson Co. — *Galenite, Cerussite*(!), Plumbogummite.

PHELPS Co. — *Specular Iron Ore, Red Hematite, Siderite, Limonite* Ankerite.

PILOT KNOB, Iron Co. — *Specular Iron Ore*, Serpentine, Magnetite, Quartz, Manganese Ore.

ST. FRANÇOIS Co. — Tungstite, *Wolframite, Magnetite*, Menaccanite (?).

ST. GENEVIEVE COPPER MINES, St. Genevieve Co. — *Chalcopyrite, Cuprite, Malachite*(!), *Azurite* (!), Chalcocite, Bornite, *Covellite*, Melaconite, Chalcanthite.

ST. LOUIS. — *Millerite* (!!), *Dolomite, Calcite, Fluorite*, Anhydrite, Gypsum.

SALINE Co. — Halite.

SAMPSON'S COAL MINE, Moniteau Co. — *Galenite* and *Sphalerite* in cannel coal.

SCOTIA IRON BANKS, Crawford Co. — *Specular Iron Ore*(!), *Quartz, Jasper*, Amethyst, Goethite, Malachite.

SIMMONS MOUNTAIN, Dent Co. — *Specular Iron Ore.*

STANTON COPPER MINES, Franklin Co. — Native Copper, *Chalcotrichite*, Malachite, Azurite, Chalcopyrite.

VALLE MINES, Jefferson Co. — *Galenite, Cerussite, Anglesite* (!), *Calamine*(!), *Smithsonite*, Hydrozincite, Malachite, Azurite.

VIRGINIA MINES, Frankiin Co. — Galenite, Minium, Cerussite, Anglesite.

WAYNE Co. — Limonite.

WEBB CITY, Jasper Co. — *Galenite, Sphalerite.*

Magnetic Survey of Missouri. *Fourth Annual Report.*

By Francis E. Nipher.

During the years 1878, '79 and '80 the magnetic survey of Missouri had been extended to all parts of the State, and it was clear that in the further and more detailed prosecution of the work it would not be advantageous to travel by rail. Fortunately the requirements of the case were fully met by the unsolicited offer of a gentleman of St. Louis to pay the expense involved in the completion of the work. His interest in the work was also shown in the many well-considered suggestions in regard to the fitting out of the expedition, and which added very greatly to our comfort.

We were provided with two horses and a strong spring-wagon capable of carrying all our instruments, two tents, folding-cot, etc. The wagon was built especially for the purpose, and was provided with high-backed seats which could be let down so as to make a comfortable couch at night.

In addition to the instruments taken in previous years, a Green's barometer (No. 1423, belonging to the University) was carried. It was suspended from the roof of the wagon on two steel spirals, one of which ordinarily supported the instrument, the other being brought into play during heavy jolting. The instrument was also guyed by lateral spirals, so that it required very little attention.

I was accompanied by Mr. W. E. Knollenberg of the Junior class, who acted as volunteer assistant, and by Mr. Andrew O'Reilly of the Freshman class, who was employed to relieve us of the burden of camp duties, but who also rendered important service in the observations. To both of these gentlemen I wish to express a feeling of personal obligation for the manner in which they rendered enjoyable the rough experiences incidental to camp life in a sparsely settled region, and during a peculiarly oppressive summer.*

* The temperature, as shown by a carefully exposed thermometer, very frequently rose to 100° F.; for several days at a time it rose to 104° F., and once reached 109° F.

Mr. B. D. Kribben again aided the survey by assuming charge of the weather service during the summer.

It is perhaps proper to state, that, owing to the fact that we could control our own movements perfectly, we were enabled to do about four times as much work as in previous years when we travelled by rail.

When travelling from one station to another a star observation for meridian was made at every camp and the eastern elongation of the needle was determined the next morning, even when we did not care to do more. In such cases the mean scale reading of the magnet for the day was calculated by subtracting $3._7$ divisions or $7'._0$ from the reading at eastern elongation, correcting to the axis in the usual way. This value for half the daily swing is calculated from 33 complete determinations made during the summer. The probable error of one determination is 2′. The work at a complete station was generally finished about 4 o'clock P.M., and we invariably moved from five to ten miles before camping for the night, making a check determination as explained above. The barometer and thermometers were usually read at 7 A.M., 2 P.M., and 9 P.M., St. Louis time, observations at the University being made at the same hours.

The stations where observations were made are described below, the numbers being continued from previous reports.

STATION 55 — *near Clayton, St. Louis Co.* Lat. 38° 41′; lon. 90° 19′. On the farm donated by George Partridge to Washington University. The observations were made directly in front of the house and 73 ft. from the line of the front fence. The alarm clock failed to awaken us and the pole-star observation was missed. The meridian was therefore determined by sun observations the next day.

STATION 56. Lat. 38° 38′; lon. 90° 23′. On the grounds of Rock Hill church, near the Ten-mile House on the Manchester road. Observations in the N.E. corner of the parsonage grounds. The N.E. corner of the house bears N. 87° $10'._3$ W., distant 66 ft. The eastern elongation of the needle was taken.

STATION 57 — *Pacific, Franklin Co.* (formerly called *Franklin*). Lat. 38° 28′; lon. 90° 44′. Observations under a large sycamore on the left bank of the Meramec river and 48 ft. from the water. A flagstaff near the depot bears N. 59° $57'._8$. W. Polaris observations for meridian and morning elongation of needle taken. This station is perhaps half a mile S. of W. from the station of 1880, and the observations of the two years agree fairly well.

STATION 58—*Union, Franklin Co.* Lat. 38° 25′; lon. 90° 59′. Observations in the lane leading to the house of .... (opposite the house of John Crow), estimated to be about midway between the barn and the road. The court-house bears S. 26° 01′.1 E. and is about ¾ of a mile distant. Polaris observation.

STATION 59—*Roedersville, Franklin Co.* Lat. 38° 24′; lon. 91° 10′. Sec. 36, tp. 43, r. 3 W. of 5th prin. meridian. The observations were made a little S. of E. from the house of J. F. Roeder, distant about 300 ft.* from Roeder's E. line, beneath two large oaks located on land owned by C. Henneke. These trees are 20 ft. from the main road fence.

On the night of the 9th the watch stopped. Before leaving St. Louis its rate had been reduced to less than half a second per day, but the intense heat of the 7th and 8th had affected the oil of its bearings. The watch had not been cleaned for two years. Returning to Washington the watch was sent to St. Louis to be cleaned. It was only roughly rated after cleaning, and was used for the rest of the summer without further regulation. Its rate was determined at the close of the summer as will be hereafter shown.

STATION 60—*Washington, Franklin Co.* Lat. 38° 31′; lon. 90° 59′. Observations in the pasture field of Dr. E. McLean, near an oak tree standing alone in the field. The station of 1879 in Dr. McLean's yard is about 1500 ft. N.E. and on the opposite side of the bluff. Two complete declination determinations were made, the second of which, however, was not fully satisfactory, as the telescope was displaced during the interval between the morning and afternoon observations. The silk fibre was also broken during the afternoon observations, which introduced a small error due to the torsion of the new fibre, the effect being increased by a rain. The two determinations differed 5′. The observations confirmed the work of 1879, which was very important. A polaris observation was made for meridian.

STATION 61—*in Franklin Co.* Lat. 38° 24′; lon. 91° 16′. On sec. 31, tp. 43, r. 3 W., in the orchard of Julius Wulfert, 164 feet W. of his house and 72 ft. from the road fence. Polaris observation and morning elongation of the needle.

STATION 62—*Canaan, in Gasconade Co.* Lat. 38° 19′; lon. 91° 32′. Sec. 11, tp. 41, r. 6 W. Farm of Wm. J. Allen, in the field about 60 rods N. of the house, near a small elm tree. An oak tree on the roadside a little S. of E. bears S. 82° 51′.3 E.; this tree is on the line of the "Kirkwood survey." Polaris observation.

STATION 63—*in Gasconade Co.* Lat. 38° 17′; lon. 91° 35′. At the crossing of the Dry Fork of Burbeuse river, about 5 miles from station 62, on the Washington and Springfield road. The observations were made at the edge of the road at a point estimated to be about two or three hundred yards beyond the crossing of the stream. The measurements and sketches

* In all cases where distances are given as approximate, they were measured in paces of 29 inches; in other cases they were measured by a 50-ft. tape line. In a few cases for long distances the distance was estimated, and it is so stated.

usually taken for the location of the station were omitted here, having been forgotten by reason of certain very unpleasant experiences * Polaris observation and morning elongation of the needle.

STATION 64—*Vienna, Maries Co.* Lat. 38° 12′; lon. 91° 54′. On the common 2½ blocks S. and 1 block E. of the S.E. corner of the court-house square; the S.W. corner of the court-house cupola bears S. 31° 34′.9 W. Two polaris observations were made: in the first one. the base of the tripod was kicked lightly just before the observation, but the observation is not thought to have suffered; in the second observation the reading of the elongation was taken just after the observation, but the morning verification and mark reading were lost. as the instrument was dismounted too soon. The two determinations differed 0′.5.

STATION 65—*in Miller Co.* Farm of John Lawson, near the middle of the S.W. ¼ of S.E. ¼ of sec. 26, tp. 40, r. 12 W. Lat. 38° 11′; lon. 92°11′. The observations were made on the side of the hill 58 feet E. of the yard fence and 160 ft. from the N.E. corner of the yard, which is nearly N. of the station. Polaris observation.

STATION 66—*Tuscumbia, Miller Co.* Lat. 38° 12′; lon. 92° 30′. Observations on the hillside S.W. from the village and 65 ft. above the valley between. The N.W. chimney of the court-house was used as a mark. Polaris observation.

STATION 67—*Versailles, Morgan Co.* Lat. 38° 25′; lon. 92° 53′. Station south of town on the Linn-creek road. Station 104 ft. from the S.W. corner of the cemetery and 117 ft. from the monument of Aaron Webb. Two polaris observations.

STATION 68—*in Morgan Co.* Near farm of Leo Meyer. Lat. 38° 17′; lon. 92° 50′. This station is on the Versailles—Linn Creek road. 14 miles from the former and 16 miles from the latter place. It was a camping station, the morning elongation being determined. A polaris observation was made, but no mark was used, as we were obliged to travel very late in order to reach water. The station was in the timber by the roadside about 100 yds. S. of the ford across Soap creek. The instrument tent was pitched between two fine springs 15 ft. apart.

STATION 69—*Linn Creek, Camden Co.* Lat. 38° 04′; lon. 92° 47′. Station S.W. of town on the banks of Linn creek. The observations were made 24 ft. N. of the trunk of a large elm, which was not very high, but the top had a diameter of 50 ft. Polaris observation.

STATION 70—*Decaturville, Camden Co.* Lat. 37° 54′; lon. 92° 43′. Observations near the road N.E. from the house of James Rogers. The left side of the chimney of his house bears S. 28° 13′.4 W. from the station, and is distant 238 ft. The alarm clock failed to awaken us and we were obliged to make a sun observation the next day. For the afternoon series the instrument was clamped too low by 10 degs. and the error was not dis-

* This is the only place in Missouri where we have been put upon the defense in order to protect our property. The character of the people of this community is well known in the county, and it must be confessed that they are not a credit to the county.

covered until the time for equal-altitude observation had passed. The two series were therefore reduced separately as alt-azimuth observations.*

STATION 71 — *Lebanon, Laclede Co.* Lat. 37° 48′; lon. 92° 42′. The station is 250 ft. S. of the track of the St. Louis & San Francisco Ry., and the N.E. corner of the depot bears S. 59° 02′.₀ W. from the station, being distant 879 ft. This station is about 900 ft. a little N. of E. from the station of 1879. A polaris observation was made, but no evening mark reading was obtained.

STATION 72—*Buffalo, Dallas Co.* Lat. 37° 37′; lon. 93° 06′. In a pasture field of Thomas Welch north-west of town. The declination station was about 100 ft. S. of a small persimmon grove. This station was about 200 ft from the Ft. Scott road, and was estimated to be about ¼ of a mile E. of the mill. Polaris observation.

STATION 73 — *in Polk Co.* Lat. 37° 36′; lon. 93° 11′. Farm of Henry Voris, which is on sec. 36, tp. 34, r. 21 W., and about 6 miles from Buffalo on the Bolivar road. Station in the orchard, 295 ft. from the road fence and 150 ft. from the W. line of the front yard. Polaris observation and a single reading of C_6 at 6:10 o'clock A.M.

STATION 74 — *Bolivar, Polk Co* Lat. 37° 35′; lon. 93° 24′. Station S. of town, near the South-west Baptist College. The N.E. corner of the front of the building bears S. 13° 40′ E., and is distant 138 feet. Polaris observation.

STATION 75 — *Wheatland, Hickory Co.* Lat. 37° 56′; lon. 93° 24′. Station on the common 81 ft. N. and 13 ft. W. of the N.W. corner of the public square. On sec. 24, tp. 37, r. 23 W. Polaris observation made and the morning elongation of the needle determined.

STATION 76 — *Warsaw, Benton Co.* Lat. 38° 14′; lon. 93° 23′. Observations on the hill to the E. of town, and 339 ft. from a brick house which seems to have been a school-house. The S.W. pinnacle of a brick church just across the valley, in town, bears S. 66° 12′.₆ W. The alarm clock failed us again and a sun observation was made for meridian.

STATION 77—*Lincoln, Benton Co.* Lat. 38° 23′; lon. 93° 21′. This station is just E. of the Sedalia road in the "old village." The German Lutheran church (N.E. corner) bears S. 71° 21′.₂ W., and is 429 ft. distant. Polaris observation.

STATION 78 — *Windsor, Henry Co.* Lat. 38° 32′; lon. 93° 33′. Station on the N.W. side of Commercial st. (50 ft. distant) and in the prolongation of the next street N.E. of Benton st. From the station, a perpendicular laid off to the track of the Missouri, Kansas & Texas Ry. measures 346 ft. Polaris observation.

STATION 79—*in Johnson Co.* Lat. 38° 41′; lon. 93° 34′. Farm of Geo. Zimmerman, which is the W. ½ of the N.E. ¼ of sec. 11, tp. 45, r. 24 W. The observations were made in Mr. Zimmerman's yard, 104 ft. from the front fence and 176 ft. E. of the E. side of the garden. Polaris observation.

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* See Trans. vol. iv. No. 1, p. 83.

STATION 80—*in Johnson Co.* Lat. 38° 52′; lon. 93° 35′. Valley of the Blackwater, on the farm of Milton Swope, which is the E. ½ of the N.E. ¼ of sec. 4, tp. 47, r. 24 W. Observations in the orchard, 87 ft. S. of the garden fence and 103 ft. W. of the orchard gate. Polaris observation and morning elongation of needle.

STATION 81—*Sweet Springs, Saline Co.* Lat. 38° 55′; lon. 93° 29′. Station on the banks of Blackwater, near the N.W. corner of the fair-grounds. A point on the fair-grounds fence distant 134 ft. bears S. 52°27′.3 E., and is 198 ft. S. of the N.W. corner of the grounds. The corner of the grounds bears S. 109° 46′.3 E. from the station. The meridian was determined by a polaris observation, which was not fully satisfactory by reason of clouds. It, however, served a good purpose as a check. A sun observation was made, and two determinations for magnetic meridian were also made.

STATION 82—*Herndon, Saline Co.* Lat. 39° 00′; lon. 93° 21′. A camping station. True meridian determined by a polaris observation and magnetic meridian determined from the morning elongation. The station is just S. of the post-office, in a small yard of J. M. Riggins just N.E. of his house. The distances from the W., S. and E. fences are 81 ft., 189 ft. and 106 ft. The E. side of the yard is bounded by the Marshall road.

STATION 83—*Marshall, Saline Co.*, Lat. 39° 08′; lon. 93° 17′. This station is in the northern edge of the city in the street leading N. from the N.E. corner of the court-house square. Measuring from a culvert which passes through a high "fill," the station is 128 ft. N. and 147 ft. E. Two star observations.

STATION 84—*Arrow Rock, Saline Co.* Lat. 39° 06′; lon. 93° 00. Observations in a deep ravine S. of town. The station was at the base of the bluff, on the right bank of the water-way, 160 ft. above the crossing of the Booneville road and 35 ft. above the large elm. Polaris observation.

STATION 85—*in Howard Co.* On farm of Clark Bros., on sec. —, tp. 49, r. 17 W. Lat. about 39° 02′; lon. approx. 92° 55′. Seven and a half miles from Booneville. The number of the section could not be learned. The place is easily found by means of the fine spring a few rods E. of the house. The observations were made on the N.E. side of the road, 508 ft. S.E. of the gate leading to the front door of Clark's house. A polaris observation was made and the morning elongation was determined. We camped late and no mark was used.

STATION 86—*Clark's Fork, Cooper Co.* Lat. 38° 51′: lon. 92° 40′. On farm of W. F. Johnston, which is the E. ½ of N.E. ¼ of sec. 2, tp. 27, r. 16. The observations were made near the N.W. corner of the quarter section, a few feet W. of the main water-way and due E. of the spring on the adjoining farm belonging to C. C. Eldredge. A polaris observation was made ½ an hour after elongation.

STATION 87—*Prairie Home, Cooper Co.* Lat. 38° 48′; lon. 92° 39′. On sec. 19, tp. 47, r. 15 W. The station was on the common N.E. of the house of Dr. Lacy. Measurements *across* the roads t the fences on the W. and S. showed each to be 115 ft. distant. The road on the S. is known as the

Palestine road. Polaris observation and morning elongation of the needle observed.

STATION 88 — *California, Moniteau Co.* Lat. 38° 39′; lon. 92° 38′. On sec. 15, tp. 45, r. 15; on the farm of W. F. Meyer. A triangulation station of the U. S. Coast and Geodetic Survey bears S. 109° 09′.5 E., being distant 114 ft. Polaris observation.

STATION 89 — *Centreton, Cole Co.* Lat. 38° 38′; lon. 92° 31′. On farm of Wm. S. Freshour, who lives just at the edge of the village. The station was on the line between secs. 25 & 26, tp. 45, r. 14, and about 50 ft. S. of the Jefferson City road. This was a camp station, no mark reading having been taken, and the morning elongation being determined. Polaris observation.

STATION 24 *d—Jefferson City, Cole Co.* Lat. 38° 35′; lon. 92° 09′. Observations were made on the common in front of the barn of Phil. E. Chappell. The station was 90 ft. N. of the N.E. corner of the barn, and in line of the E. end of the barn. A polaris observation was made and the morning elongation was taken. This observation was made in order to determine whether the long-continued and wide-spread drouth had affected the position of the needle. This drouth had extended not only over the entire State, but over a large part of the United States. In Missouri everywhere except on the river bottoms the crops had suffered very greatly. Forest trees were dying everywhere; the grass of the meadows crumbled underfoot and burned like tinder. The only plants which seemed to thrive were the well known pests, the cocklebur (*Xanthium strumarium*) and the Jamestown-weed (*stramonium*), which imparted its disagreeable flavor to the milk of the cows, showing to what straits they were reduced for food. Streams and springs were dried up, and for a week at a time we were sometimes unable to obtain a drink of wholesome water. During the latter part of the summer we were obliged to buy water for the horses.

It had been suggested in a previous report that the abnormal easterly deviation at Jefferson City might be the result of unequal conducting power, the earth currents flowing in greater quantity up the moist valley of the Missouri, the general direction of which is here N.W. to S.E. It seemed probable, if this explanation were a correct one, that this effect might be still greater during the present year by reason of the drouth which had affected the soil of the upland more than that of the valleys. The result gave no countenance whatever to the explanation, the declination being (Aug. 24, 1881) 8° 25′.2, while the value observed in 1879 (Aug. 12) at a point only a few rods distant was 8° 27′.2. Nevertheless it was observed that this value was from half a degree to a degree greater than the declination farther up the valley, on either side, but more remote from the river, and it seemed quite probable that the 8° 30′ line must curve down the river from near Glasgow along the left slope, crossing near Jefferson City and returning along the right slope of the valley. In order to settle this point observations were made at the two stations next named. The results there gave an unmistakable negative to the question which was asked. It seems to be conclusively settled that this river valley does not have the marked influence upon the magnetic needle which had been suggested in previous reports. It is. of course, possible that the effect here is masked by other effects due to other causes. It is, perhaps, well to consider the question an open one until other regions which now indicate the influence of variations of contour are examined with more minuteness.* The later work of the summer showed that the area of maximum declination which had been detected lies to the *east* of Jefferson City, extending as far as Hermann. If it is connected with the region of equal values to the west, it is by a narraw isthmus immediately south of Jefferson City.

STATION 90 *a.* — *Marion, Cole Co.* Lat. 38° 42′; lon. 92° 25. About 13 miles above Jefferson City. Station on the right bank of the Missouri river about midway between the road and the water's edge, and about 1,000 ft. below the village. The instrument was set under a large elm tree. Two polar observations and two complete declinations.

STATION 90 *b.*—This station bears S. 100° 58′ W. from station *a.* and is distant about 800 ft. The meridian at this station was deduced from observations at station *a.* by an obvious method explained in the previous report. The magnetic meridian was determined as follows :—Before the declinometer was dismounted at station *a.*, the University magnetometer was set up, and the two needles were read simultaneously at 5 P.M. The declinometer was then dismounted and was set up at station *b.*, and simultaneous readings were again made, at 5:30 P.M. The magnetometer needle changed $1'._4$, and this correction was applied to the reading at station *b.* This practically makes the result at this station as good as that at station *a.* The result at station *b.* differed $3'._6$ from the mean at station *a.*, and the two at *a.* differed $2'._6$ from each other. Instead of being more than at Jefferson City, the declination was about 50′ *less*. Hence from Jefferson City the declination diminishes very rapidly to the N.W.

STATION 91 — *Providence, Boone Co* Lat. 38° 49′; lon. 92° 28′. Near the E. line of sec. 20, tp. 47, r. 13 W. The station of observation was on the northern edge of the village, near the Columbia road. Starting at the N.E. corner of the residence lot owned by J. T. McBain, the station is reached by going in an easterly direction, at right angles to the front fence, a distance of 8 ft., and then northerly but parallel to the front fence a distance of 165 ft. The Columbia road passes in front of McBain's house, and then turns westward winding up the steep bluff. Polaris observation and morning elongation of the needle. The declination was practically the same as at Marion. From this point the declination evidently increases to the N.W., although not rapidly, the change between Providence and Arrow Rock being only 16′.

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* The *observed* declinations in the Magnetic Survey of France and Belgium, by Rev. S. J. Perry, published in the Trans. of the Royal Soc. of London, 1872, indicate a similar tendency of the needle to set at right right angles to contour lines. The stations are not sufficiently numerous, however, to be conclusive.

STATION 92—*near Columbia, Boone Co.* Lat. 38° 56′; lon. 92° 18′. On the St. Charles road, 2 miles E. of Columbia. The station was on an oid track of the road 237 ft. from the forks of the Richland and St. Charles roads. The junction of the two roads is in front of W. L. Arnold's house. The numbers of the land could not be learned. Polaris observation.

STATION 93—*McCredie, Callaway Co., Mo.* Lat. 38° 58′; lon. 91° 55′. Station will be found by starting at the intersection of the Columbia and St. Charles road with the Chicago & Alton R.R., measuring 630 feet west along the centre of the Columbia road, thence south 236 feet. Sun observations.

STATION 94—*in Callaway Co.* Lat. 38° 57′; lon. 91° 47′. In sec. 8, tp. 48, r. 8 W., on the farm of C. H. Loomis. The station was 37 ft. from the W. edge of Auxvasse creek, 117 ft. N. from the centre of the St. Charles road (as seen to the W.), and 17 ft. E. of the centre of a neighborhood road which runs up the W. side of the creek. Polaris observation and morning elongation of the needle.

STATION 95—*Danville, Montgomery Co.* Lat. 38° 51′; lon. 91° 32′. Station just W. of town, in the angle of the Columbia road where it turns S., and three squares W. of the court-house square. Polaris observation and morning elongation of the needle.

STATION 96—*Warrenton, Warren Co.* Lat. 38° 46′; lon. 91° 08′. The numbers of the lana could not be learned from the owner. The station was perhaps half a mile S. of the St. Charles road, on a road which crosses it near the E. end of the city, and in the centre of a small "slough" just N. of the farm-house of Christ Drake. This house displays a sign upon which stands the legend, "Cheap John, from Paris, Tailor." Polaris observation.

STATION 97—*Dardenne Prairie, St. Charles Co.* Lat. 38° 43′: lon. 90° 42′. Station about ½ a mile E. of Dardenne P. O. in the pasture field of Strother Johnson, under a persimmon tree about 160 ft. from the road fence, and about 345 ft. from the west side of the yard. Polaris observation and a morning elongation of the needle.

STATION 98 *a*.—*St. Louis Co.* Lat. 38° 44′; lon. 90° 31′. Opposite St. Charles on the "rock road." The station was just at the base of the bluffs, under a large elm tree on the W. side of Taussig av., 410 ft. N. of the centre of the St. Charles and St. Louis "rock road." Polaris observation and a morning elongation. The declination value was much larger than was anticipated, and a check observation was made at station 98 *b*., the observation being made as at 98 *b*.

STATION 98 *b*.—On the S. side of the rock road, 369 ft. E. of the centre of Taussig av. The result was 7′ less than at station *a*. This abnormal result was certainly not produced by the railroad bridge, which is very much too far away.

STATION 99—*Pattonsville, St. Louis Co.* Lat. 38° 42′; lon. 90° 29′. On farm of Wm. Post, about ½ a mile S.E. of the village. Station 92 ft. from the centre of the rock road (in a S.W. direction) and 308 ft. from the door-yard fence (in a S.E. direction). The declination here agrees very well with the numerous other values determined around St. Louis, but differs 1° 30′ from the value at the previous station, about 5 miles distant. Polaris observation.

STATION 100 — *Florissant, St. Louis Co.* Lat. 38° 47′; lon. 90° 17′. In the yard of Henry Aubuchon, who lives in the edge of the village on the St. Louis rock road. Station 84 ft. E. of the centre of the St. Louis road, and 194 feet from the centre of the street N. of the yard. Polaris observation and morning elongation.

Redetermination of the Temperature constant (q) for Magnet C_6.

This quantity was determined in March, 1879, but at that time the facilities at hand made it a matter of great difficulty to secure accurate results. It was necessary to remove the deflecting magnet in order to determine the angle of deflection, as at that time a second instrument was not available.

The redetermination was made in the basement room below the physical laboratory, known as the "clock room." Two solid brick piers set well into the ground served to support the instruments. The magnetometer was mounted on the south pier, with needle C_{17} suspended and C_6 deflecting. Declinometer No. 3, with magnet No. 1 suspended, was mounted on the north pier, and served to determine the corrections for hourly change in declination. The scale values of the suspended magnets are, C_{17}, $2'.{}_{89}$; No. 1, $1'.{}_{90}$; and the scales are so mounted that when the easterly declination increases, the scale reading of No. 1 increases, while that of C_{17} diminishes.

Both magnets had been suspended for a week. The suspending fibres were examined for torsion just before the series began. One had 5 degs. of twist, which was corrected, while the other was without torsion.

At 2 o'clock P.M. of the 11th of October, 1881, the scales read

C_{17} 79.0	No. 1 .... 77.95

At 3 P.M. magnet C_6 was put in place deflecting C_{17}, its centre being 21 inches west of the zero point of the deflection bar, with N. pole west. It was surrounded with a jacket of ice-water which was fed by a drip of ice-water during the next night. The next morning the readings of the needles were taken as follows:

Hour.	Scale Reading.		Temp. of C_6.	Temp. of Room.
	No. 1.	C_{17}.		
8 30	82.0	149.15	67.5	70
— 45	81.6	149.5	67.4	70
9 40	80.55	150.0	67.5	70
10 15	79.9	150.2	67.6	70
		Mean	67.5	

At 10:15 the ice-water was gradually removed, and hydrant water was substituted, which was gradually warmed. The following readings were then taken:

Hour.	Scale Reading.		Temp. of C_6.	Temp. of Room.
	No. 1.	C_{17}.		
11 55	77.3	150.9	103.	71
12 10	77.4	151 2	104.	72
12 20	77.4	151.0	105.	72
12 35	77.5	151.0	104.	72
12 50	77.5	150.9	105.	72
1 00	77.5	150.9	104.	72
1 17	77.6	151.1	105.3	72
		Mean	104.3	

At 1:18 P.M. the doors of the water-bath were opened, and C_6 was allowed to cool down slowly, the water being finally replaced by ice-water as before. The readings were then

Hour.	Scale Reading.		Temp. of C_6.	Temp. of Room.
	No. 1.	C_{17}.		
4 00	78.3	151.5	66.	72.
4 14	78 5	151.8	66.	72.
4 25	78.65	151.8	66.8	72.2
4 36	78.65	151.75	67.5	72.5
4 45	79.0	151.7	67.8	72.5
		Mean	66.8	

At 4:55, C_6 being removed, the suspended magnets read

No. 1 .... 78.95 | C_{17} 79.35

The mean reading of No. 1 was $78._7$ and the readings of C_{17} were corrected to this value as is shown in the following table, which explains itself. In applying this correction to C_{17} the sign of the correction, for reasons before stated, is of course reversed.

	Magnet No. 1.		Corr. in Scale Div. of C_{17}.	Reading C_{17}.	Corrected Reading C_{17}.	
	Reading.	Corr. to Mean.				
Series I.	82.0	— 3.3	+ 2.2	149.15	151.4	Mean 151.25.
	81.6	— 2.9	+ 1.9	149.5	151.4	
	80.55	— 1.85	+ 1.2	150.0	151.2	
	79.9	— 1.2	+ 0.8	150.2	151.0	
Series II.	77.3	+ 1.4	— 0.9	150.9	150.0	Mean 150.04.
	77.4	+ 1.3	— 0.86	151.2	150.3	
	77.4	+ 1 3	— 0.86	151.0	150.2	
	77.5	+ 1.2	— 0.8	151.0	149.2	
	77.5	+ 1.2	— 0.8	150.9	150.1	
	77.5	+ 1.2	— 0.8	150.9	150.1	
	77.6	+ 1.1	— 0.7	151.1	150.4	
Series III.	78.3	+ 0.4	— 0.26	151.5	151.24	Mean 151.66.
	78.5	+ 0.2	— 0.13	151.8	151.67	
	78.65	+ 0.05	— 0.03	151.8	151.77	
	78.65	+ 0.05	— 0.03	151.75	151.72	
	79.0	— 0.3	+ 0.19	151.70	151.89	

For the lower temperatures, t_0 Series I. and III., we have the mean readings:

	t_0.	C_{17} reads
Series I.	$67._5$	$151._{25}$
" III.	$66._8$	$151._{66}$
Mean	$67._{15}$...	$151._{46}$

For the higher temperature,

	t.	C_{17} reads
Series II.	$104._3$	$150._{04}$

Hence a change in temperature of $37°._{15}$ F. produces a change of $1._{42}$ divisions in the reading of C_{17}.

The angle of deflection at the lower temperature was determined from the simultaneous readings before and after the experiments as is here shown:

	Series I.		Series III.
No. 1 read	77.95	......	78.95
Mean of day	78.7	......	78.7
Correction to mean	+ 0.75	......	— 0.25
Reduced to scale value of C_{17}	— 0.49	......	+ 0.16
C_{17} read	79.0	......	79.35
C_{17} corrected	78.51	......	79.51
C_{17} during deflection	151.25	......	151.66
Angle of deflection in scale div.	72.74 div.		72.15 div.

Hence the mean angle u at the lower temperature t_0 is 72.45 div. or $3° 29'.4$.

Using the notation,

s = scale value of C_{17} ($= 2.'89$),
u = deflection at lower temperature ($= 3° 29'.4$),
l = length of 1′ in units of radius,
d = change in scale reading of C_{17} (1.42), for change $(t—t_0)$ in temperature of (C_6), where $t — t_0 = 37°.15$ F.

Then
$$q = \frac{s.\ d.\ l.}{t — t_0} . \cot u .$$

Substituting the known values, we have

$$q = 0.00047 .$$

In 1879 the result was

$$q = 0.00048^{*}.$$

The result indicates that the determination of 1879 is satisfactory, and the table of temperature corrections then deduced and given on p. 90 (*loc. cit.*) based on the value 0.00048 has been used in reducing the observations of the present report.

After this determination the deflecting magnet C_6 was, through a misunderstanding, left in the cool air-bath and the next morning it was found to have oxidized. This made it important to redetermine the moment of inertia as function of temperature.

A series of determinations beginning October 18, 1881, and closing Mar. 29, 1882, was therefore made, the experiments being conducted

* Trans. vol. iv. No. 1, pp. 88–90.

substantially as in 1878. The work was done on the south pier of the clock room. The temperature of the room varied slowly from day to day, and for most of the work advantage was taken of these fluctuations in order to observe at different temperatures. Beginning with Mar. 23d, however, the temperature of the magnet was raised to between 90° and 103° F. by means of a water-jacket of sheet copper which surrounded the magnetometer except at the bottom, which rested upon the flat stone with which the pier is capped. The front wall of the jacket was provided with a window to admit of telescopic observation, and the sides were provided with small windows for illumination of the scale, and to allow the reading of the thermometer which was placed inside the magnet box. These windows were closed with double walls of thin mica. The top of the jacket was pierced to admit the passage of the torsion head, the annular space around the suspension tube being packed with cotton to prevent the hot air of the interior from escaping. The jacket was of course examined to determine whether it acted magnetically, but no such effect could be detected. It was, of course, necessary to remove the water-jacket for a few minutes in order to adjust the inertia ring, but care was always taken to allow time enough to elapse to secure a constant temperature.

The time of oscillation was determined by means of a Bond chronograph, No. 171, connected in circuit with the astronomical clock Howard No. 214.

Part of these observations were made by Mr. W. R. Vickroy of the Junior class, who also made all of the calculations, which were afterwards revised by myself. In the reduction the observations for Feb. 16 were rejected.

The observations and reductions are given in the following tables, where t is the temperature of the magnet during the loaded series, T' the time of vibration of the magnet loaded with inertia ring Y and corrected for torsion, T the time of vibration of the magnet alone, corrected for torsion, and reduced to the temperature of the loaded series. These differences of temperature were always small. k'_t is the moment of inertia of ring Y at the temperature t,* and k_t is the moment of inertia of the magnet at a temperature t, while k_0 is the moment of inertia of the magnet at the mean temperature of $64._7$ F.

* Trans. vol. iv. No. 1, p. 86.

DATE.	t.	log T^2.	log T'^2	log (T'^2-T^2)	log $\frac{T^2}{T'^2-T^2}$	log k'_t	log k_t	$y =$ log k_0—log k_t	$u = t - 64.7$	uy.	u^2.
Oct. 18	68·7	1·69226	1·88895	1·45031	0·24195	0·98131	1·22326	— 0·00032	+ 4·0	—0·00128	16·00
Nov 3	65·5	1·69239	1·88919	1·45074	0·24165	0·98128	1·22293	+ 1	+ 0·8	+0·00001	0·64
10	58·4	1·69195	1·88766	1·44730	0·24465	0·98122	1·22587	— 293	— 6·3	+0·01846	39·69
Dec. 8	65·0	1·69140	1·88732	1·44733	0·24407	0·98128	1·22535	— 241	+ 0·3	—0·00072	0·09
31	54·0	1·68949	1·88563	1·44602	0·24347	0·98118	1·22465	— 171	—10·7	+0·01830	114·49
Jan. 1	48·5	1·68748	1·88442	1·44623	0·24125	0·98113	1·22238	+ 56	—16·2	—0·00907	262·44
2	51·0	1·68767	1·88462	1·44643	0·24124	0·98115	1·22239	+ 55	—13·7	—0·00754	187·69
3	53·0	1·68793	1·88493	1·44683	0·24110	0·98117	1·22227	+ 67	—11·7	—0·00784	136·89
4	51·1	1·68772	1·88509	1·44761	0·24011	0·98115	1·22126	+ 168	—13·6	—0·02285	184·96
4	50·4	1·68725	1·88477	1·44759	0·23966	0·98114	1·22080	+ 214	—14·3	—0·03060	204·49
13	63·0	1·69122	1·88711	1·44707	0·24415	0·98126	1·22541	— 247	— 1·7	+0·00420	2·89
17	52·0	1·68854	1·88542	1·44710	0·24144	0·98116	1·22260	+ 34	—12·7	—0·00432	161·29
18	48·0	1·68751	1·88483	1·44728	0·24023	0·98112	1·22135	+ 159	—16·7	—0·02655	278·89
19	53·5	1·68958	1·88651	1·44827	0·24131	0·98117	1·22248	+ 46	—11·2	—0·00515	125·44
26	66·5	1·69141	1·88807	1·44923	0·24218	0·98128	1·22346	— 52	+ 1·8	—0·00094	3·24
28	61·5	1·69007	1·88724	1·44943	0·24064	0·98124	1·22188	+ 106	— 3·2	—0·00339	10·24
Feb. 2	61·2	1·69011	1·88708	1·44894	0·24117	0·98124	1·22241	+ 53	— 3·5	—0·00186	12·25
4	65·5	1·69051	1·88756	1·44956	0·24095	0·98128	1·22223	+ 117	+ 3·4	+0·00398	11·56
5	68·1	1·69195	1·88918	1·45148	0·24047	0·98130	1·22177	+ 71	+ 0·8	+0·00057	0·64
16	105·0	1·69869	1·89729	1·46196	0·23673	0·98163	[1·21836]	* ……	……	……	……
23	99·7	1·69621	1·89232	1·45268	0·24353	0·98158	1·22511	— 217	+35·0	—0·07595	1225·00
26	103·5	1·69738	1·89455	1·45675	0·24063	0·98161	1·22224	+ 70	+38·8	+0·02716	1505·44
Mar. 4	96·0	1·69702	1·89448	1·45719	0·23983	0·98155	1·22138	+ 156	+31·3	+0·04883	979·69
29	86·5	1·69439	1·89078	1·45160	0·24279	0·98146	1·22425	— 131	+21·8	—0·02856	475·24
Mean = t_0	64·7					log k_0	1·22294		Sums	—0·10511	5939·19

* Evidently wrong, but error unknown.

Calling Δk the change in log k_t for $1^{\circ} F$, the moment of inertia of the magnet may be represented by the formula

$$\log k_t = \log k_0 + (t - 64.7)\, \Delta k.$$

The observations of the table give 23 equations of the form

$$e = \log k_0 - \log k_t + (t - 64.7)\, \Delta k\,, \text{ or}$$
$$e = \qquad y + \qquad u\, \Delta k\,.$$

The value of Δk which best satisfies these equations is

$$\Delta k = - \frac{[uy]}{[u^2]},$$

where the square brackets indicate the summation of all expressions similar to those enclosed. This calculation is given in the last columns of the table, from which we have

$$\Delta k = + \frac{0.10511}{5939.2} = 0.000018\,.$$

The value for 1878 was 0.000015.
Adopting the value of $\Delta k = 0.000017$, we have for the value of log k_t,

$$\log k_t = 1.22294 + 0.000017\,(t - 64.7),$$

from which the following table is obtained:

t.	log. k_t.
50	1.22269
60	1.22286
70	1.22303
80	1.22320
90	1.22337
100	1.22354

F^0.	P.P. log.
1	2
2	3
3	5
4	7
5	9
6	10
7	12
8	14
9	15

The value of Δk turns out to be practically the same as in 1878, as was to have been expected. The value of log. k for any given temperature is less than in 1878 by an amount which would be accounted for by the removal of about 50 milligrammes (25 mgrs. from each side) from points distant $0._1$ foot from the axis of rotation, this being approximately the radius of gyration. Unfortunately the magnet had not been weighed, so that this check has not the same value that it might have had.* It is thought, however, that most of this difference is accounted for by the loss in mass of the magnet and the wear of the stirrup. The work of the present year, and of all previous years, has therefore been reduced by means of the tables of 1878, while in subsequent work the value of log. k_t will be obtained from the preceding table.

Intensity Determinations.

During the summer eleven complete determinations of intensity were made at regular intervals. These observations serve to determine the value of P in the equation for the deflection series, and lead to a determination of the magnetic moment of C_6 for the summer. The other determinations of intensity were relative and were reduced to absolute value by calculating the magnetic moment for the respective days of observation, from the formula which represents the value of the magnetic moment for the summer.

These calculations are given in the following tables.

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* April 17, 1882, magnet C_6 weighed 103.667 grammes.

Determination of *P* for the Summer of 1881.

Station.	Date.	LOGARITHMS. r^3 tan u.	r'^3 tan u'.	r tan u.	r' tan u'.	*A*.	*B*.	*P*.	*P*.
Clayton	July 4	9.50395	9.50337	8.90189	9.01729	6.63347 *p*	8.38525 *n*	8.24822 *n*	— 0.0177
Union	" 8	9.48403	9.48177	8.88197	8.99569	7.19866 *p*	8.35813 *n*	8.84053 *n*	— 0.0693
Roedersville	" 9	9.48350	9.48379	8.88144	8.99771	6.30103 *n*	8.36855 *n*	7.93248 *p*	+ 0.0086
Canaan	" 16	9.48250	9.48254	8.88044	8.99646	5.47712 *n*	8.36648 *n*	7.11064 *p*	+ 0.0013
Vienna	" 18	9.48851	9.49050	8.88645	9.00442	7.15229 *n*	8.38075 *n*	8.77154 *p*	+ 0.0591
Versailles	" 25	9.48675	9.48700	8.88469	9.00092	6.23045 *n*	8.37162 *n*	7.85883 *p*	+ 0.0072
Lebanon	" 30	9.46972	9.46828	8.86766	8.98220	6.99123 *p*	8.34735 *n*	8.64388 *n*	— 0.0440
Buffalo	Aug. 1	9.47191	9.47123	8.86985	8.98515	6.66276 *p*	8.35282 *n*	8.30994 *n*	— 0.0204
Sweet Springs	" 13	9.49252	9.49068	8.89046	9.00460	7.12057 *p*	8.36847 *n*	8.75210 *n*	— 0.0561
Clark's Fork	" 20	9.49522	9.49290	8.89316	9.00682	7.22272 *p*	8.36903 *n*	8.85369 *n*	— 0.0714
St. Louis	Sept. 8	9.52394	9.52497	8.92188	9.03890	6.89763 *n*	8.41212 *n*	8.48551 *p*	+ 0.0306
								Sum......	— 0.1721

The mean value of P for the summer is therefore $-0.{}_{01564}$; and hence for reducing the two deflection series in which the distances r and r' between the magnets are 2 ft. and $1_{.75}$ ft., we have the values

$$1 - \frac{P}{2^2} = 1.{}_{0039} \qquad \log = 0.{}_{00169}$$

$$1 - \frac{P}{(1._{75})^2} = 1.{}_{0051} \qquad \log = 0.{}_{00221},$$

and these values have been used in all the calculations for the present report.

Magnetic Moment of C_6 for Summer of 1881.

Date.	t.	$t-90._7$	log $1+(t-90.7)q$.	log m_t.	log m.	Days.	d.	$y=$ log m_0-log m	yd.	d^2.
July 4	94.9	+ 4.2	0.00088	9.86741	9.86829	0	— 21	—0.00136	+ 0.02856	441
" 8	104.2	+13.5	0.00281	9.86239	9.86520	4	— 17	+ 173	— 0.02941	289
" 9	94.1	+ 3.4	0.00081	9.86557	9.86638	5	— 16	+ 55	— 0.00880	256
" 9	94.1	+ 3.4	0.00081	9.86561	9.86642	5	— 16	+ 51	— 0.00816	256
" 16	94.6	+ 3.9	0.00082	9.86446	9.86528	12	— 9	+ 165	— 0.01485	81
" 16	94.6	+ 3.9	0.00082	9.86468	9.86550	12	— 9	+ 143	— 0.01287	81
" 18	77.4	—13.0	9.99727	9.87106	9.86833	14	— 7	— 140	+ 0.00980	49
" 25	81.4	— 9.3	9.99805	9.86863	9.86668	21	0	+ 25	0.00000	0
" 30	96.3	+ 5.6	0.00116	9.86611	9.86727	26	+ 5	— 34	— 0.00170	25
Aug. 1	92.1	+ 1.4	0.00029	9.86733	9.86762	28	+ 7	— 69	— 0.00483	49
" 13	84.1	— 6.6	9.99862	9.86952	9.86814	40	+ 19	— 121	— 0.02299	361
" 20	82.9	— 7.8	9.99837	9.86929	9.86766	47	+ 26	— 73	— 0.01898	676
Sept. 8	88.6	— 2.1	9.99956	9.86775	9.86731	66	+ 45	— 38	— 0.01710	2025
Mean t	90.7			log m_0 =	9.86693	21		Sums...	— 0.10133	4589

Hence for the summer of 1881 the daily decrease in log m is $a = \frac{-0.10133}{4589} = -0.000022$, and represents an *increase*. The value of log m at a temperature of $90._7$° F. is

$$\log m = 9.86693 + 0.000022\, d,$$

where d is estimated from July 25th.

For all observations where the deflection series were not made the oscillation series was reduced to the temperature of $90^\circ.7$, and the formula on the preceding page was used in determining the magnetic moment for the day.

In order to determine the rate of the watch, Jürgensen 10890, it was compared on eight different days with Dent No. —, and the loss per second was determined as follows:

This mean of 0.00037, second per second, was used in reducing the work of the summer.

0.00028
35
39
36
40
39
42
38
0.00037

The horizontal intensity in the present report and in all former reports is as yet uncorrected for the influence of the magnetic brasswork of the magnetometer. The formula for correcting the values of 1879, 1880, and 1881, is given in the report for 1879,* and is

$$H = (1 - 0.0070)\, H'',$$

where H'' is the observed and H the corrected value.

Declination.

The declination determinations were all made with magnet No. 1, in declinometer No. 3. The observed values of declination have received a correction of 2′. for the effect of the magnetic brasswork of the instrument as determined in 1880.† The determinations are given in the following tables, which explain themselves.

Meridian Determinations at Decaturville, July 29, 1881.‡

The altitude and azimuth circle readings are the means of seven observations.

	A.M.	P.M.
Altitude (lower limb)	52° 32′.5	42° 32′.5
App. Zenith distance	37 27 .5	47 27 .5
Sun's radius	— 15 .8	— 15 .8
Refraction	+ 0 .7	+ 1 .0
True Zenith distance	37 12 .4	47 12 .7

* Trans. vol. iv. No. 1, p. 134. † Trans. vol. iv. No. 2, p. 340.

‡ See description of this station on p. 456 of this report.

A.M.

Lat.	37°	55′.0		a. c. cos	0.10297
Decl.	18	38 .0			
Z. D.	37	12 .4		a. c. sin	0.21847
2 S.	93	45 .4			
S.	46	52 .7		cos	9.83478
Decl.	18	38 .0			
S. — dec.	28	14 .7		sin	9.67508
sin $^2 \frac{1}{2} a$					19.83130
$\frac{1}{2} a$	55°	26′		sin	9.91569
Sun's azimuth N.	110°	56′.	E.		
" " S.	69	04 .0	E.		
Hor. circle, Sun reads	82	46 .4			
South reads	151	50 .4			

P.M.

Lat.	37°	55′		a. c. cos	0.10297
Decl.	18	34 .6			
Z. D.	47	12 .7		a. c. sin	0.13434
2 S.	103	42 .3			
S. =	51	51 .2		cos	9.79077
Decl.	18	34 .6			
S. — dec.	33	16 .6		sin	9.73932
sin $^2 \frac{1}{2} a$					19.76740
$\frac{1}{2} a$	49°	54′.7		sin	9.88370
Sun's azimuth N.	99°	49′.4	W.		
" " S.	80	10 .6	W.		
Hor. circle, Sun reads	231	54 .2			
South reads	151	43 .6			

Mean reading of South		151°	47′.0	
Mark reads		180	00 .7	
Azimuth of mark	S.	28	13 .7	W.

Meridian Determinations by method of equal altitudes of the Sun.

Station.	Date.	No. of Obs.	t.	$\frac{1}{2}(A+A')$.	e.	log $\Delta d''$.
Clayton	July 5	9	29° 28′.5	264° 29′.9	0′.4	1.76193
Warsaw	Aug. 7	9	34 00 .1	113 46 .7	0 .4	2.28443
Sweet Springs.	" 14	7	41 40 .0	220 52 .3	0 .1	2.40838
McCredie	" 30	4	40 27 .8	255 14 .7	0 .1–	2.46255

Station.	Cor.	South reads	Mark reads	Azim. mark.
Clayton	+1′.2	264° 31′.1	180° 01′.4	S. 84° 29.7 E.
Warsaw	+2.9	113 49 .6	180 00 .1	S. 66 10.5 W.
Sweet Springs	+4.1	220 56 .4	180 01 .5	S. 40 54.9 E.
McCredie	+4.8	255 19 .5	180 01 .1	S. 75 18.4 E.

In the table t is half the sidereal interval between the A.M. and P.M. observations, A and A' are the readings of the horizontal circle, and e is the probable error of the mean (uncorrected) reading of south, treating $\frac{1}{2}(A+A')$ as constant. Δd is the increase in solar declination (in seconds) during the time $2t$. The correction to be applied to $\frac{1}{2}(A+A')$ is given in the succeeding column.

Polaris Observations for Meridian.

Station.	Date.	Azim. Circle. Vernier A. Mark reads	Azim. Circle. Vernier A. Polaris reads	Azimuth of Elongation	North reads	Azimuth of Mark.	Remarks.
Rock Hill Church	July 6	180° 00′.7	126° 01′.7	1° 41′.9	124° 19′.8	S. 124° 19′.1 E.	
Pacific *b*.	" 7	202 32 .0	264 11 .5	1 41 .7	262 29 .8	" 120 02 .2 W.	
Union	" 8	332 18 .0	180 00 .7	1 41 .6	178 19 .1	" 26 01 .1 E.	No evening mark reading.
Roedersville	" 9	182 01 .5	200 56 .7	1 41 .6	199 15 .1	" 162 45 .8 W.	Evening mark indistinct.
Washington	" 12	180 00 .7	75 49 .5	1 41 .8	74 07 .7	" 74 07 .0 E.	
Wulfert's	" 14	180 00 .5	102 59 .3	1 41 .7	101 17 .6	" 101 17 .1 "	
Canaan	" 15	180 00 .6	84 33 .3	1 41 .4	82 51 .9	" 82 51 .3 "	
Dry Fork	" 16	180 00 .8	145 23 .2	1 41 .4	143 41 .8	" 143 41 .0 "	
Vienna	" 18	180 00 .1	213 16 .7	1 41 .2	211 35 .5	" 148 24 .6 W.	
"	" 19	180 00 .7	213 16 .0	1 41 .2	211 34 .8	" 148 25 .9 "	No morning mark.
Lawson's	" 20	180 00 .7	288 55 .2	1 41 .2	287 14 .0	" 72 46 .7 "	
Tuscumbia	" 21	0 00 .0	325 47 .5	1 41 .3	324 06 .2	" 144 06 .2 E	
Versailles	" 23	180 01 .7	167 04 .5	1 41 .6	165 22 .9	" 165 21 .2 "	Very damp nights, moisture all over the instruments, which were in tent. Tripod warped about 2′.
"	" 24	180 01 .7	167 05 .7	1 41 .6	165 24 .1	" 165 22 .4 "	
Meyer's	" 26	....	180 02 .4	1 41 .4	178 21 .0	....	No mark used.
Linn Creek	" 27	180 00 .7	78 47 .0	1 41 .1	77 05 .9	" 77 05 .2 E.	
Lebanon	" 30	178 27 .2	206 20 .2	1 40 .6	204 39 .6	" 153 47 .6 W.	No evening mark reading.
Buffalo	" 31	268 00 .0	1 00 .0	1 40 .5	359 19 .5	" 88 40 .5 "	" " " "
Voris's farm	Aug. 1	180 01 .0	272 32 .2	1 40 .5	270 51 .7	" 89 09 .3 "	

Bolivar	Aug.	2	180 01 .2	108 10 .7	1 40 .5	106 30 .2	S. 106 29 .0 E.	Morning mark indistinct.
Wheatland	"	5	180 01 .2	6 31 .5	1 41 .0	4 50 .5	" 4 49 .3 "	
Lincoln	"	7	180 00 .7	152 51 .0	1 41 .6	151 09 .4	" 151 08 .7 "	
Windsor	"	8	176 12 .2	38 24 .0	1 41 .7	36 42 .3	" 40 30 .1 "	No evening mark reading.
"	"	9	176 12 .7	38 25 .5	1 41 .7	36 43 .8	" 40 31 .1 "	
Zimmerman's	"	10	180 00 .7	24 55 .2	1 41 .9	23 13 .3	" 23 12 .6 "	
Swope's	"	11	180 02 .2	78 33 .5	1 42 .3	76 51 .2	" 76 49 .0 "	
Sweet Springs	"	12	180 00 .5	42 40 .2	1 42 .4	40 57 .8	" 40 57 .3 "	Not very good, clouds interfered.
Herndon	"	14	154 59 .2	180 01 .2	1 42 .5	178 18 .7	" 203 19 .5 W.	No evening mark reading.
Marshall	"	15	180 00 .7	251 48 .5	1 42 .7	250 05 .8	" 109 54 .9 "	
"	"	16	180 00 .7	251 48 .5	1 42 .7	250 05 .8	" 109 54 .9 "	
Arrow Rock	"	17	180 00 .7	127 03 .2	1 42 .6	125 20 .6	" 125 19 .9 E	
Clark's farm	"	18	....	180 00 .7	1 42 .5	178 18 .2	....	No mark used.
Clark's Fork	"	19	180 01 .5	174 10 .2	1 42 .3	272 27 .9	" 87 33 .6 W.	
Prairie Home	"	20	180 00 .7	286 00 .5	1 42 .2	284 18 .3	" 75 42 .4 "	
California	"	21	180 00 .6	274 03 .0	1 41 .9	272 21 .1	" 87 39 .5 "	
Centreton	"	22	....	180 00 .0	1 41 .9	178 18 .1	....	No mark used.
Jefferson City	"	23	179 48 .7	179 59 .5	1 41 .8	178 17 .7	" 178 29 .0 E.	No evening mark reading.
Marion	"	24	180 21 .7	255 26 .7	1 42 .0	253 44 .7	" 106 37 .0 W.	" " " "
"	"	25	180 21 .5	255 27 .0	1 42 .0	253 45 .0	" 106 36 .5 "	
Providence	"	27	180 00 .5	324 29 .7	1 42 .2	322 47 .5	" 37 13 .0 "	
E. of Columbia	"	28	180 01 .5	58 27 .7	1 42 .4	56 45 .3	" 56 43 .8 E.	
Loomis's farm	"	30	180 00 .7	270 31 .2	1 42 .4	268 48 .8	" 91 11 .9 W.	
Danville	"	31	....	96 35 .2	1 42 .3	94 52 .9	....	No mark used.
Warrenton	Sept.	1	297 46 .2	180 00 .0	1 42 .1	178 17 .9	" 60 31 .7 E.	No evening mark reading.
Dardenne	"	3	180 00 .7	277 04 .2	1 42 .1	275 22 .1	" 84 38 .6 W.	
St. Charles	"	4	180 00 .5	241 25 .7	1 42 .1	239 43 .6	" 120 16 .9 "	
Pattonsville	"	5	180 00 .9	146 38 .7	1 42 .1	144 56 .6	" 144 55 .7 E.	
Florissant	"	6	180 00 .5	246 37 .7	1 42 .1	244 55 .6	" 115 04 .9 W.	

Magnetic Declination or "Variation."

STATIONS.	MAGNET SCALE. Elongations. East.	West.	Mean.	Axis reads.	Reduction to Axis.	AZIMUTH CIRCLE. Circle reads.	Magnetic South reads.	Mark reads.	True South reads.	DECLINATION. Uncorrected.	Corrected.	Date.
Near Clayton	82ᵈ.6	76ᵈ.7	79ᵈ.65	78ᵈ.76	+1′.7	270°31′.0	270°32′.7	180°01′.3	264°31′.0	6°01′.7	6°03′.7	July 5
Rock Hill Church..	80.0	....	76.3	[78.8]	—4.7	311 10.0	311 05.3	180 00.7	304 19.8	6 45.5	6 47.5	" 6
Pacific..................	79.4	....	75.7	[78.8]	—5.7	89 27.7	89 22.0	202 32.1	82 29.9	6 52.1	6 54.1	" 7
Union	82.3	73.8	78.0	78.2	—0.4	364 53.2	364 52.8	332 18.0	358 19.1	6 33.7	6 35.7	" 8
Roedersville	82.7	74.1	78.4	[78.2]	+0.4	26 09.2	26 09.6	182 01.7	19 15.9	6 53.7	6 55.7	" 10
Washington	80.1	73.5	76.8	78.3	—2.7	260 25.0	260 22.3	180 00.7	254 07.7	6 14.6	6 16.6	" 12
"	80.9	72.2	76.5	[78.3]	—3.4	260 30.7	260 27.3	180 00.7	254 07.7	6 19.6	6 21.6	" 13
Wulfert's.............	81.2	....	77.5	[78.3]	—1.5	288 21.2	288 19.7	180 00.5	281 17.6	7 02.1	7 04.1	" 15
Canaan	81.1	75.7	78.4	[78.3]	+0.2	270 06.2	270 06.4	180 00.5	262 51.8	7 14.6	7 16.6	" 16
Dry Fork..............	78.3	....	....	[78.3]	—7.0	330 51.5	330 44.5	180 00.8	323 41.8	7 02.7	7 04.7	" 17
Vienna	80.2	74.5	77.4	77.7	—0.6	38 42.5	38 41.9	180 00.7	31 36.1	7 15.8	7 17.8	" 18
"	80.1	75.8	78.0	77.7	+0.6	38 45.2	38 45.7	180 01.0	31 35.1	7 10.6	7 12.6	" 19
Lawson's.............	81.0	....	77.3	78.0	—1.3	114 07.2	114 05.9	180 00.7	107 14.0	6 51.9	6 53.9	" 21
Tuscumbia...........	80.4	74.2	77.3	78.4	—2.1	152 38.2	152 36.1	359 58.5	144 07.7	8 28.4	8 30.4	" 22
Versailles	80.1	74.1	77.1	78.3	—2.3	353 43.5	353 41.2	180 02.0	345 23.8	8 17.4	8 19.4	" 24
"	80.1	72.5	76.3	[78.3]	—3.8	353 42.7	353 38.9	179 59.5	345 21.3	8 17.6	8 19.6	" 25
"	79.8	72.4	76.1	[78.3]	—4.2	353 46.2	353 42.0	180 00.7	345 22.5	8 19.5	8 21.5	" 26
Meyer's farm	80.0	....	76.3	[78.3]	—3.8	6 43.5	6 39.7	....	358 21.0	8 18.7	8 20.7	" 27
Linn Creek	80.9	72.5	76.7	[78.3]	—3.0	266 07.0	266 04.0	180 00.5	257 05.7	8 58.3	9 00.3	" 28
Decaturville	81.8	74.9	78.1	[78.3]	—0.4	160 42.2	160 41.8	180 00.6	151 47.2	8 54.6	8 56.6	" 29
Lebanon..............	81.0	74.3	77.6	78.6	—1.9	33 52.0	33 50.1	180 00.0	26 12.4	7 37.7	7 39.7	" 30
Buffalo	82.0	74.2	78.1	[78.6]	—1.0	187 24.0	187 23.0	267 58.5	179 18.0	8 05.0	8 07.0	Aug. 1
Voris's farm	81.0	....	77.3	[78.6]	—2.5	99 01.2	98 58.7	180 01.2	90 51.9	8 06.8	8 08.8	" 2

Bolivar	81.3	72.7	77.0	78.3	—2.5	294 45.0	294 42.5	180 01.7	286 30.7	8 11.8	8 13.8	Aug. 3
"	81.3	74.2	77.8	[78.3]	—0.9	294 45.0	294 44.1	180 01.7	286 30.7	8 13.4	8 15.4	" 4
Wheatland	81.1	....	77.4	[78.3]	—1.7	193 30.2	193 28.5	180 01.7	184 51.0	8 37.5	8 39.5	" 6
Warsaw	80.2	72.5	76.4	[78.3]	—3.6	122 42.5	122 38.9	180 00.2	113 49.7	8 49.2	8 51.2	" 7
Lincoln	80.6	72.9	76.7	[78.3]	—3.0	340 28.5	340 25.5	180 00.2	331 08.9	9 16.6	9 18.6	" 8
Windsor	80.7	75.2	77.9	[78.3]	—0.2	225 24.5	225 24.3	176 12.2	216 42.8	8 41.5	8 43.5	" 9
Zimmerman's	81.7	74.0	77.8	[78.3]	—1.0	212 27.5	212 26.5	180 00.7	203 13.3	9 13.2	9 15.2	" 11
Swope's	82.3	....	78.6	[78.3]	+0.6	265 25.5	265 26.1	180 01.9	256 50.9	8 35.2	8 37.2	" 12
Sweet Springs	81.7	74.0	77.8	78.0	—0.4	230 19.5	230 19.1	180 01.5	220 56.4	9 22.7	9 24.7	" 13
"	81.2	75.2	78.2	[78.0]	+0.4	230 16.5	230 16.9	180 00.7	220 55.6	9 21.3	9 23.3	" 14
Herndon	78.4	....	74.7	[78.0]	—6.3	7 18.2	7 11.9	154 .9.2	358 18.7	8 53.2	8 55.2	" 15
Marshall	80.4	73.4	76.9	78.2	—2.5	78 38.7	78 36.2	180 00.7	70 05.8	8 30.4	8 32.4	" 16
Arrow Rock	82.2	76.2	79.2	[78.2]	+1.9	313 11.5	313 13.4	180 01.5	305 21.4	7 52.0	7 54.0	" 18
Clark's farm	81.7	....	78.0	[78.2]	—0.4	6 10.7	6 10.3	....	358 18.2	7 52.1	7 54.1	" 19
Clark's Fork	81.6	75.6	78.6	[78.2]	+0.8	99 53.2	99 54.0	180 00.7	92 27.1	7 26.9	7 28.9	" 20
Prairie Home	80.5	....	76.8	[78.2]	—2.7	111 56.7	111 54.0	180 00.7	104 18.3	7 35.7	7 37.7	" 21
California	82.7	75.2	78.9	[78.2]	+1.3	100 01.2	100 02.5	180 00.0	92 20.5	7 42.0	7 44.0	" 22
Centreton	82 3	....	78.6	[78.2]	+0.8	5 53.2	5 54.0	....	358 18.1	7 35.9	7 37.9	" 23
Jefferson City	83.4	....	79.7	[78.2]	+2.9	6 40.0	6 42.9	179 48.7	358 17.7	8 25.2	8 27.2	" 24
Marion *a*	81.0	72.2	76.6	[78.2]	—3.0	81 25.2	81 22.2	180 21.5	73 44.8	7 37.4	7 39.4	" 25
" *a*	80.3	72.5	76.4	78.2	—3.4	81 23.2	81 19.8	180 21.7	73 45.0	7 34.8	7 36.8	" 26
" *b*	....	....	76.3	[78.2]	—3.6	76 13.2	76 09.6	180 01.5	68 29.9	7 39.7	7 41.7	" 26
Providence	82.5	....	78.8	[78.2]	+1.1	150 23.2	150 24.3	180 00.5	142 47.5	7 36.8	7 38.8	" 28
E. of Columbia	81.5	....	77.8	[78.2]	—1.0	244 08.5	244 07.5	180 01.6	236 45.4	7 22.1	7 24.1	" 29
McCredie	80.8	74.7	77.7	78.1	—0.8	263 08.5	263 07.7	180 00.7	255 19.1	7 48.6	7 50.6	" 30
Loomis's farm	82.2	....	78.5	[78.1]	+0.8	96 32.2	96 33.0	180 00.5	88 48.6	7 44.4	7 46.4	" 31
Danville	81.6	....	77.9	[78.1]	—0.4	282 39.0	282 38.6	....	274 52.9	7 45.7	7 47.7	Sept. 1
Warrenton	80.4	73.2	76.8	[78.1]	—2.5	185 02.7	185 00.2	117 46.2	178 17.9	6 42.3	6 44.3	" 2
Dardenne	80 5	....	76.8	[78.1]	—2.5	101 55.2	101 52.7	180 00.7	95 22.1	6 30.6	6 32.6	" 4
St. Charles *a*	80.0	....	76.3	[78.1]	—3.4	67 08.2	67 04.8	180 00.5	59 43.6	7 21.2	7 23.2	" 5
" *b*	....	....	78.4	[78.1]	+0.6	65 02.2	65 02.8	180 01.0	57 49.1	7 13.7	7 15.7	" 5
Pattonsville	82.0	74.4	78.2	78.1	+0.2	330 49.0	330 49.2	180 01.6	324 57.3	5 51.9	5 53.9	" 6
Florissant	81.4	....	77.7	77.9	—0.4	71 29.0	71 28.6	180 00.5	64 55.6	6 33.0	6 35.0	" 7

Intensity — Oscillations.

STATION.	Date.	t'. Temp.	LOGARITHMS. T'^2.	$1 + \frac{h}{f}$	$1-(t'-t)q$	T^2.	k.	mH.	H.	H.
Near Clayton	July 4	97°0	1.68770	0.00044	9.99956	1.68770	1.22364	0.53024	0.66283	4.601
Union	" 8	107.9	1.67758	0.00033	9.99923	1.67714	1.22380	0.54096	0.67807	4.765
Roedersville	" 9	96.2	1.67126	0.00053	9.99956	1.67135	1.22362	0.54657	0.68100	4.797
"	" 9	96.5	1.67126	0.00053	9.99950	1.67135	1.22363	0.54664	0.68103	4.798
Wulfert's	" 15	85.5	1.66896	0.00037	0.00108	1.67041	1.22347	0.54736	0.68065	4.794
Caanan	" 16	101.2	1.67302	0.00043	9.99863	1.67208	1.22370	0.54592	0.68124	4.800
Vienna	" 18	82.2	1.66656	0.00040	9.99907	1.66603	1.22341	0.55168	0.68062	4.793
Lawson's	" 20	99.0	1.65990	0.00039	9.99827	1.65856	1.22369	0.55943	0.69261	4.927
Tuscumbia	" 22	85.5	1.65886	0.00039	0.00108	1.66033	1.22347	0.55744	0.68989	4.897
Versailles	" 25	81.0	1.66770	0.00045	0.00008	1.66823	1.22339	0.54946	0.68083	4.796
Linn Creek	" 27	83.0	1.65744	0.00044	0.00161	1.65949	1.22343	0.55824	0 69058	4.904
Lebanon	" 30	92.7	1.65448	0.00042	0.00068	1.65558	1.22357	0.56229	0.69618	4.968
Buffalo	Aug. 1	91.5	1.65512	0.00045	0.00013	1.65570	1.22356	0.56216	0.69483	4.953
Bolivar	" 2	100.0	1.65448	0.00041	9.99797	1.65448	1.22368	0.56512	0.69801	4.989
Wheatland	" 5	100.5	1.66616	0.00049	9.99795	1.66460	1.22369	0.55339	0.68622	4.855
Lincoln	" 8	98.6	1.66426	0.00046	9.99835	1.66307	1.22366	0.55489	0.68765	4.871
Windsor	" 9	101.0	1.66948	0.00042	9.99785	1.66775	1.22370	0.55028	0.68304	4.820
Zimmerman's	" 10	98.5	1.65810	0.00046	9.99858	1.65714	1.22366	0.56082	0.69354	4.938
Sweet Springs	" 13	89.8	1.67202	0.00048	9.99881	1.67131	1.22353	0.54652	0.67700	4.753
Herndon	" 15	85.1	1.67354	0.00042	0.00117	1.67513	1.22346	0.54263	0.67524	4.734
Marshall	" 16	100.2	1.68372	0.00046	9.99801	1.68219	1.22368	0.53579	0.66840	4.660
Arrow Rock	" 18	98.7	1.68398	0.00044	9.99833	1.68275	1.22366	0.53521	0.66775	4.653
Clark's Fork	" 20	84.1	1.67392	0.00046	9.99975	1.67413	1.22344	0.54361	0.67432	4.724
California	" 22	95.1	1.67480	0.00050	9.99902	1.67432	1.22361	0.54359	0.67604	4.743
Marion	" 26	104.0	1.67594	0.00049	9.99729	1.67372	1.22374	0.54432	0.67669	4.750
Providence	" 27	104.5	1.67720	0.00047	9.99719	1.67486	1.22375	0.54319	0.67553	4.737
McCredie	" 30	97.2	1.67732	0.00043	9.99885	1.67660	1.22364	0.54134	0.67362	4.717
Warrenton	Sept. 2	74.0	1.67404	0.00046	0.00351	1.67801	1.22328	0.53957	0.67178	4.697
Dardenne	" 3	81.0	1.67416	0.00047	9.99797	1.67260	1.22340	0.54510	0.67729	4.757
St. Charles	" 4	97.7	1.69674	0.00051	9.99854	1.69579	1.22365	0.52216	0.65433	4.512
Pattonsville	" 4	91.5	1.68572	0.00059	9.99983	1.68614	1.22356	0.53172	0.66389	4.612
Florissant	" 6	93.5	1.68646	0.00061	9.99941	1.68648	1.22359	0.53141	0.66353	4.608

Intensity — Deflections.

Station.	Date.	t.	r ft.	Logarithms. $u^{div.}$	$1 + \frac{h}{f}$	Corrected tan u.	m.	$\frac{m}{H}$
Near Clayton	July 4	96.2	2.00	1.67491	0.00109	8.60086		9.20461
" "	" 4	93.7	1.75	1.84803	0.00109	8.77426	9.86741	9.20455
Union	" 8	103.2	2.00	1.65514	0.00096	8.58094		9.18469
"	" 8	105.3	1.75	1.82861	0.00096	8.75466	9.86287	9.18495
Roedersville	" 9	95.0	2.00	1.65453	0.00104	8.58041		9.18416
"	" 9	93.2	1.75	1.82854	0.00105	8.75468	9.86561	9.18497
Canaan	" 16	95.8	2.00	1.65353	0.00104	8.57941		9.18316
"	" 16	93.4	1.75	1.82713	0.00121	8.75343	9.86468	9.18372
Vienna	" 18	77.1	2.00	1.65961	0.00097	8.58542		9.18917
"	" 18	78.3	1.75	1.83533	0.00095	8.76139	9.87106	9.19168
Versailles	" 25	81.7	2.00	1.65782	0.00100	8.58366		9.18741
"	" 25	81.0	1.75	1.83187	0.00092	8.75789	9.86863	9.18818
Lebanon	" 30	96.7	2.00	1.64083	0.00097	8.56663		9.17038
"	" 30	96.0	1.75	1.81312	0.00099	8.73917	9.86611	9.16946
Buffalo	Aug. 1	91.8	2.00	1.64301	0.00099	8.56882		9.17257
"	" 1	92.4	1.75	1.81611	0.00095	8.74212	9.86733	9.17241
Sweet Springs	" 13	85.0	2.00	1.66356	0.00100	8.58943		9.19318
"	" 13	83.2	1.75	1.83542	0.00104	8.76157	9.86952	9.19186
Clark's Fork	" 20	82.4	2.00	1.66623	0.00104	8.59213		9.19588
"	" 20	83.4	1.75	1.83759	0.00108	8.76379	9.86929	9.19408

Inclination, or Dip.

Needle No. 2.

STATION.	Marked End.		Means by Polarities.		Resulti'g Dip.	Date.	
	North.	South.	Series I.	Series II.			
Union	68°37′.6	69°03′.0	68°41′.1	68°59′.5	68°50′.3	July	8
Roedersville	68 52 .4	68 56 .9	68 47 .7	69 01 .6	68 54 .6	"	10
Canaan	68 31 .7	68 51 .1	68 34 .6	68 48 .2	68 41 .4	"	16
Vienna	68 28 .7	68 47 .9	68 32 .4	68 44 .2	68 38 .3	"	18
Lawson's	68 06 .4	68 23 .1	68 06 .8	68 22 .6	68 14 .7	"	20
Tuscumbia	68 02 .3	68 02 .7	68 03 .2	68 02 .0	68 02 .6	"	22
Versailles	68 39 .7	68 48 .4	68 44 .0	68 43 .8	68 44 .2	"	25
Linn Creek	67 59 .2	68 20 .3	68 01 .1	68 18 .5	68 09 .8	"	27
Buffalo	67 37 .0	68 15 .8	67 54 .5	67 58 .4	67 56 .4	Aug.	1
Bolivar	67 40 .7	67 55 .3	67 37 .3	67 58 .8	67 48 .0	"	2
Wheatland	67 51 .9	68 22 .3	68 01 .9	68 19 .5	68 10 .7	"	5
Lincoln	68 08 .0	68 28 .2	68 10 .8	68 25 .4	68 18 .1	"	8
Windsor	68 23 .3	68 11 .9	68 24 .6	68 10 .6	68 17 .6	"	9
Zimmerman's	68 12 .9	68 17 .9	68 14 .1	68 16 .8	68 15 .4	"	11
Sweet Springs	68 45 .4	69 07 .0	68 51 .3	69 01 .1	68 56 .2	"	13
Marshall	69 19 .5	69 45 .2	69 28 .8	69 35 .8	69 32 .3	"	16
Clark's Fork	69 01 .6	69 18 .4	69 02 .2	69 17 .8	69 10 .0	"	20
California	68 02 .2	69 06 .3	68 07 .8	69 00 .7	68 34 .3	"	22
Marion	68 37 .1	68 56 .6	68 37 .2	68 56 .0	68 46 .8	"	26
Providence	68 40 .9	69 07 .8	68 49 .4	68 59 .3	68 54 .4	"	27
McCredie	68 57 .4	69 00 .8	69 05 .5	68 52 .6	68 59 .1	"	30
Warrenton	68 52 .0	69 17 .1	68 58 .5	69 10 .6	69 04 .5	Sept.	2
Dardenne	68 45 .6	69 07 .9	68 50 .7	69 02 .8	68 56 .8	"	3
St. Charles	70 01 .2	70 14 .3	70 02 .5	70 12 .9	70 07 .7	"	4
Pattonsville	69 22 .8	69 52 .3	69 31 .6	69 43 .5	69 37 .6	"	6

Needle No. 3.

STATION.	Marked End.		Means by Polarities.		Resulti'g Dip.	Date.	
	North.	South.	Series I.	Series II.			
Vienna	68°54′.1	68°27′.9	68°39′.2	68°42′.8	68°41′.0	July	18
Versailles	68 58 .3	68 34 .4	68 39 .2	68 53 .4	68 46 .3	"	25
Linn Creek	68 35 .6	68 02 .8	68 20 .8	68 17 .6	68 19 .2	"	27
Buffalo	68 13 .1	67 42 .2	67 57 .2	67 58 .1	67 57 .6	Aug.	1
Bolivar	68 05 .7	67 35 .1	67 49 .9	67 50 .8	67 50 .4	"	2
Lincoln	68 42 .1	68 12 .0	68 28 .6	68 25 .5	68 27 .0	"	8
Windsor	68 53 .7	68 16 .0	68 31 .2	68 38 .5	68 34 .8	"	9
Zimmerman's	68 26 .9	67 55 .3	68 10 .2	68 11 9	68 11 .1	"	11
Sweet Springs	69 10 .8	68 46 .5	68 56 .4	69 00 .7	68 58 .6	"	13
Marshall	69 47 .2	69 24 .1	69 34 .2	69 37 .1	69 35 .6	"	16
California	69 12 .4	68 45 .7	68 54 .6	69 03 .5	68 59 .1	"	22
Marion	69 03 .2	68 35 .5	68 49 .6	68 49 .2	68 49 .4	"	26
McCredie	69 26 .9	68 54 .6	69 10 .9	69 10 .6	69 10 .8	"	30
St. Charles	70 20 .5	69 56 .3	70 07 .9	70 08 .9	70 08 .4	Sept.	4
Pattonsville	69 56 .3	69 26 .8	69 41 .7	69 41 .4	69 41 .6	"	6

Carboniferous Rocks of Eastern Kansas.

By G. C. Broadhead.

From the eastern line of Kansas to the Verdigris the country is either undulating or of long gentle slopes, but sometimes hilly. The surface is varied by occasional mounds and ridges which rise 100 to 150 feet above the lower plains. These are capped with limestones, which have preserved them from entire disintegration. The lower slopes from the mounds are long and gentle, and include chiefly sandstones and shales, with occasional thin limestone layers with rarely a thin coal seam.

The general elevation of the country above the sea does not greatly vary in this distance of about 100 miles east and west, being 910 to 1,000 feet at Ft. Scott, 875 at Paola, 947 at Olathe, 970 at Garnett; and in the valley of the Neosho it is 921 at Parsons, 1,000 feet at Neosho Falls, and 1,160 at Emporia. From Neosho we rise to 1,145 at Yates Centre on divide between the Neosho and Verdigris, descending to 925 feet in the valley of Verdigris near Toronto.

West of this the country is more hilly and rugged for 30 miles, rising by terraces and rough ridges to 1,235 feet elevation at head of Fancy creek on divide between the Verdigris and Fall rivers. In Fall river valley near Twin Falls we again find ourselves resting upon a 1,000 feet elevation.

The Neosho traverses an almost flat valley or trough in the lower part of the middle coal measures, only productive in coal in its southern extension, but northwardly in Osage county coal is mined, which, according to Prof. Mudge, belongs to the lower measures. This, then, shows an uplift of lower (middle?) coal measures, flanked to the east and west, as we proceed northwardly, by the upper coal measures.

In Neosho, Wilson, Labette and Montgomery counties there are numerous exposures of sandstone, which often occur in very even flag-like layers. Near Chanute and Thayer these sandstones show about 50 feet thickness, with coal at Thayer low in the hills, which is extensively worked on an area of about six miles square. Associated with the coal are many fossil plant remains, including

Calamites, *Lepidodendron*, *Stigmaria*, *Annularia*, and *Sigillaria*, with probably eight or ten species of ferns, including *Neuropteris loschii*, *N. hirsuta*, *N. angustifolia*, *N. rarinervis*, *Sphenopteris tridactylites*, and *Alethopteris serlii*. The coal is generally 14 to 18 inches thick, not separated at Thayer and with no limestone over the coal, but four miles west it is divided by several inches of clay, and a few miles north of this a limestone bed appears above the coal. At first a person might suppose these coals different, but extended observation proves them to be the same as that at Thayer. No limestone appears above the coal at Thayer. The following is a complete section showing these changes where best developed, seven miles northwest from Thayer. On the hilltop sandstone is exposed, and 30 feet below the strata appear thus:

1, 2 feet limestone;
2, 6 feet dark shale, lower part bituminous;
3, 0 to 1 foot concretionary limestone;
4, 10 inches calcareous shale and concretionary limestone;
5, 3 feet sandy and clay shale;
6, 6 inches blue clay shale;
7, 10 inches coal;
8, $4\frac{1}{2}$ inches clay;
9, 6 inches coal;
10, 25 feet shales and clay;
11, 18 inches ferruginous limestone conglomerate;
12, 4 feet clay shales.

In the western part of Missouri, in Cass and Jackson counties, the lower 200 feet of the upper coal measures is well developed and shows abundant evidence of former molluscan life.

These beds (limestone chiefly, separated by clay and calcareous shale beds) are also readily recognized in Johnson and Wyandotte counties, Kansas. At Eudora the thickness, lithological appearance, and organic remains, are correspondingly identical with other beds seen near Parkville and on Platte river, Mo., at Union Mills, and at Plattsburgh, Clinton county, and called in Missouri Geological Report, 1872, the Plattsburgh limestone, containing numerous beautiful Bryozoans, *Pleurotomania turbiniformis*, *Petalodus destructor*, and a beautiful *Monoptera*, together with a few species of *Nautili*. Sixteen feet above this limestone is everywhere found a gray limestone abounding in *Syntrilasma* *hemiplicata*, which, together with other fossils found in the same stratum, has its interior lined with clear crystallized calcite. Just a little higher is a limestone abounding in *Fusulina cylindrica*. These beds correspond to Nos. 108 to 112 of Mo. Section [Mo. Geol. Rep. 1872, Pt. 2, p. 94].

Near Olathe are beds near this horizon, or probably a little higher but still belonging to the upper coal measures.

In the eastern part of Miami county the strata are equivalent to those of Cass and Jackson counties, Mo.

The productive coal measures lie chiefly in the eastern tier of counties south of Miami county, and include valuable coal beds. In the country southwest from Paola to Wilson county only thin coal seams are occasionally worked, with no profitable result. The last of any consequence in going westward is in the southwest part of Woodson county and less than one foot in thickness.

A general section of the rocks seen in the western part of Miami and eastern part of Franklin on the Marais des Cygnes river is as follows:

1. 22 feet irregularly bedded gray limestone, breaking into small fragments on exposure, contains *Productus splendens*, *P. punctatus*, *Spirifer cameratus*, *Syntrilasma hemiplicata*, and *Myalina subquadrata*—the interior of fossils often crystallized calcite.
2. 86 feet chiefly shales, the lower 30 feet thick layers of clay shales, with beds of clay ironstone, and a bed of red shale near upper part.
3. 20 feet gray limestone; has minute calcite veins.
4. 20 feet or more of clay shales with yellow ochre concretions.

This section includes (the upper on hilltops, the lower in the valleys) the rocks from Ossawattomie to Garnett, for over 25 miles. Near Lane and Greeley the upper is surmounted by a good building-stone of oolitic limestone, which when polished is sometimes shipped off under the name of "coralline marble." But the supposed corals are only oolitic forms, giving beauty under magnifying power, but otherwise appears like a dull dark gray. It very much resembles the Kansas City oolite, but is probably a different stratum higher in the series. The exact geological position of these beds I have not yet been able to correllate with Missouri strata, but they belong to the upper coal measures near the horizon of the rocks at Weston, Platte county.

Passing westwardly from Miami and Anderson counties we do not find our well known Missouri strata, but they seem to be replaced by other beds which still contain well recognized upper coal measure fossils. We pass from these across the lower measures of Woodson and eastern part of Greenwood county and again recognize the upper coal measures.

In Woodson and Greenwood and northeast part of Elk county we find about 50 feet of thick-bedded coarse brown sandstone almost entirely devoid of fossils, and only occasional fragments of fucoids and cordaites were seen. From this the step is rapid to other higher rocks without seeing the connected strata of the Missouri river; for there are found great thicknesses of shales with some sandstones, and an occasional limestone bed abounding in *Fusulina cylindrica*.

The valley of Fall river at Charleston is about 965 feet above the sea, at Twin Falls 1,000 feet, at Eureka 1,095, near junction of East and West forks 1,166, indicating a descent of 200 feet in 40 miles.

Entering the State near the line of Cowley and Chatauqua counties we find ourselves upon a long dividing ridge extending northwardly and well defined for 70 miles to the head of Fall river, and thence northwestwardly and northwardly.

This ridge is much higher than the country east and west, and is known in southern Kansas as the "Flint Hills," on account of the numerous fragments of flint lying strewn over the surface. It includes the Permian rocks of Kansas, and might appropriately be termed the Permian Mountains. This ridge is elevated above the sea as follows: on line of Elk and Cowley counties, 5 miles west of Greenfield, 1,560 feet; near head of Grouse creek, 1,600 feet; at head of Otter and Hickory creeks, a peak near the corner of Elk and Greenwood counties rises 1,700 feet, this probably being the highest point of this range in Kansas, and highest ground east of Walnut and Arkansas valleys.

On the west the descent from this ridge is gentle, being 270 feet in 6 miles, or 390 feet in 25 miles, and becoming less as we pass north.

On the eastern slope the descent is more abrupt, there being in fact only four good wagon passes in 70 miles—one near Greenfield, Elk Co.; the next 15 miles north of this, known as McDowell's Pass: the third on the Augusta road at head of Spring creek.

and another at the head of the Ivanpah branch of Fall river, both of the latter being near the line of Greenwood and Butler counties.

The eastern face of the ridge presents rugged walls of cream-colored limestone, separated by shaly slopes. The ascent on the east near Greenfield rises 350 feet in 4 miles, or 390 ft. in 6 miles. At McDowell's Pass the rise is 419 feet in 4 miles, or 452 feet in 7 miles. At Spring-creek Gap the rise is 312 feet in 3½ miles, or 340 feet in 5½ miles. At Ivanpah the rise is 334 feet in 5½ miles.

On the west the slopes are mostly gentle, with a second parallel ridge about 2 miles west of the main crest, separated by a valley but little below the ridge. The western ridge is also sometimes a little higher that that on the east, but its descents are so easy that it nowhere possesses the prominence of the eastern range. The general slope westwardly towards the Walnut valley is so gentle that we feel that we are still on high ground.

East of the eastern ridge spurs extend off sometimes for a distance of ten miles, presenting bold outliers connected with the lower plains by wide terraces. Among the hills a peculiar feature is generally before us of rounded hills crowned and terraced with regular limestone escarpments.

Starting from Twin Falls, in valley of Fall river, at about 1,000 feet elevation, we reach the second terrace, 6 miles southwestwardly, at 1,160 to 1,180 feet. This second plateau occupies a large portion of the eastern part of Greenwood county and most of Elk county, and includes rocks of the upper coal measures.

At the head of Salt creek, near the line of Greenwood and Elk counties, we rise from this plateau to a third terrace elevated about 1,300 feet above the sea, reaching to the foot of the "Flint Hills," and breaking off into spurs towards Howard City. This terrace includes the last coal measure rocks below the Permian.

We now proceed to the Geological details of this district.

Leaving the Verdigris river near the mouth of Walnut creek. after passing up for 60 feet, we leave the lower sandstone: we then are near the horizon of a 7-inch coal seam. Two feet above the coal we find about 8 ft. of ashy drab-colored limestone everywhere, containing *Hemipronites crassus* and some other upper carboniferous fossils, including *Meekella striato-costata* and *Spirifer cameratus*.

Seventy feet higher we find 9 feet of gray limestone, the interval between the two being chiefly occupied by shaly beds, sometimes passing into a sandstone; for example, on Fall river below Charleston.

On Fancy creek we find no other limestone above that last named for nearly 200 feet above, when we find an ash-blue limestone about 2 feet thick, containing *Protozoa;* this is again capped by 36 feet of sandstone, above which lie 35 feet of shales, with beds of limestone still above; and 100 feet still higher on the hilltop, at an elevation of 1,235 feet, another limestone bed appears. Near Twin Falls, also 7 miles east of Howard and 5 miles southwest of Charleston, we find limestone beds from near 1165 to 1200 feet above the sea abounding in Chætetes and occasionally in *Syringapora multattenuata*. Most of these limestones also seem to abound in *Fusulina cylindrica.*

West of Fall river, at 1081 feet elevation, a limestone occurs abounding in the above named *Protozoa*, also a *Nautilus* and *Syringapora multattenuata*; at 1081 bituminous shales are seen.

On Indian creek, Elk county, at 1050 feet elevation, numerous well preserved fossils were obtained from a limestone, and include fine specimens of *Myalina subquadrata* showing interior of valve, also *Nuculana bellistriata*, *Edmundia* ——, *Schizodus Wheeleri*, *Aviculopecten occidentalis*, and *Myalina perattenuata*— all well recognized upper coal measure fossils. On hills 4 miles north and 2 miles south, and at an elevation of 1130 to 1150 feet above the the sea, we find the limestones named above as abounding in Chætetes, and separated from the Indian-creek fossil bed by sandstones.

We now come to speak of the "PERMIAN" or limestones of the "Flint Hills," reaching, in Elk, Greenwood and eastern half of Butler and Cowley counties, from 1185 to 1700 feet above the sea, or including about 500 feet thickness.

The following section was observed west of Greenfield (town has since been removed and name changed to Grenola), numbering from hilltop:

Sec. A—1. 134 feet, including beds of impure drab limestone, shaly and crumbling, with occasional shale beds, with red shales 30 feet from bottom.

2. 5 feet of bluish-drab or drab limestone containing many good characteristic fossils, including *Eumicrotis hawni*, *Myalina perattenuata*, *Aviculopecten occidentalis*, etc. [This bed is persistent wherever its associated strata are found.]

Sec. A—3. 10 feet of shales, the lower red.
4. 10 " rough limestone.
5. 27 " shales with thin shaly limestone beds.
6. 4 " flag-like limestone bed; a good building-rock.
7. 8 " shelly buff magnesian limestone.
8. 4 " shaly *Fusulina* limestone.
9. 4 " cherty limestone; abounds in *Fusulina cylindrica*, the fossils often appearing in relief; the chert of a deep blue.
10. 18 feet limestone and shales abounding in *Fusulina cylindrica*.
11. 2 " drab magnesian limestone.
12. 28 " shaly sandstone.
13. 4 " gray magnesian limestone, upper part buff, abounding in *Productus semireticulatus*.
14. 17 feet shales with a buff limestone at lower part.
15. 40 " probably all shales.
16. 3 " hard rough sandstone.
17. 8 " sandy shales.
18. 1 " limestone.
19. 20 " sandy shales.

No. 1 of this section abounds in numerous fossils nicely weathered out, including small corals (*Chætetes?* and *Rhombopora*) in upper part, *Productus nebrascensis*, *P. semireticulatus*, *Meekella striato-costata*, *Chonetes granulifera*. *Terebratula bovides*, *Athyris subtilita*, *Schizodus rossicus*, *Myalina perattenuata*, *Yoldia subscitula*, and *Nautilus eccentricus*.

All above No. 12 of this section is undoubtedly of *Permian type* and the strata may be considered Permian, and all below No. 13 undoubtedly belong to the true coal measures (Up. Coal Meas.).

The following is a section observed west of Lazette, Cowley county, which includes some strata above those of the above section:

Sec. B—1. 84 feet shaly limestone and shales from hilltop.
2. 7 " chert and some limestone, a well marked bed; it is often seen strewn over the surface northeast of Lazette. *Pinna peracuta* is generally found: a *Phillipsia* was also recognized.
3. 80 feet shaly limestone beds.
4. 4 " of good building-rock, a buff limestone.
5. 5 " limestone in thin layers, contains same fossils as No. 2 of last section (A).
6. 11 feet of shales, upper red, the lower blue.
7. 1 foot of limestone.
8. 17 feet shales and nodular limestone.

The elevation of No. 5 of the last section (B) is 1215 feet; that of its equivalent No. 2 of Sec. A, west of Greenfield, 1483 feet—indicating a dip of 268 feet in about 10 miles in passing southwest, or over 26 feet per mile.

Sec. C was observed on Osborn's branch (McDowell's Gap), 15 miles north of Sec. A, on line of Elk and Butler counties, as follows:

Sec. C—1. 62 feet cherty slope, includes highest rocks observed on flint ridges; fossils observed were *Hemipronites crenistria*, *Athyris subtilita*, *Productus costatus*, and Bryozoa.
2. 4 feet of gray shelly limestone.
3. 16 " of shales.
4. 4 " rough limestone bed.
5. 20 " of shales, with bands of buff limestone containing *Fusulinæ*.
6. 41 feet of shales.
7. 3 " of limestone.
8. 3 " of red shales.
9. 64 " of shales and limestone.
10. 8 " of rough yellowish limestone.
11. 22 " of shales.
12. 1 " good bed of limestone.
13. 8 " of shales.
14. 10 " of limestone and blue chert abounding in *Fusulinæ*.
15. 4 " of shales.
16. 2 " of yellow limestone.
17. 39 " of shales.
18. 2 " of blue jointed limestone with *Fusulina cylindrica*.
19. 133 " chiefly shales, includes about two limestone beds.
20. 1 " dark ash-brown shelly limestone.
21. 25 " sandstone.

No. 20 of Sec. C corresponds to No. 18 of Sec. A, and No. 14 of Sec. C corresponds to No 9. of Sec. A. The *Fusulinæ* at this place are very perfect, and when weathered or broken off show the structure very finely.

At head of Elk river, near northwest corner of Elk county, we found very well preserved specimens of *Hemipronites crenistia*, often weathered out, and a limestone bed entirely composed of it.

At the head of Otter creek, near Carlisle Gap, I obtained fine specimens of *Allorisma subelegans*, *Al. topekaensis*, *Myalina kansasensis*, *Meekella striato-costata*, *Productus nebrascensis*, *Aviculopecten occidentalis*. *Hemp. crenistria*, *Athyris subti-*

lita, *Eumicrotis hawni*, *Aviculopinna americana*. *Macrodon* ——, *Nautilus occidentalis*, *Orthoceras* ——.

A more recent examination shows the following in cut of St. Louis and St. Francisco road west of Beaumont, on a high ridge:

1. 4 feet gravel bed.
2. 4 " shales.
3. 4 " buff limestone, abounding in *Myalina perattenuata*, *M. kansasensis*. *Aviculopecten occidentalis*. *Monotis* and *Athyris Pleurophorus* abounds in a lower stratum.

From the lower and more crystalline beds near base of the Permian I obtained on Spring creek, Greenwood county, fine specimens of *Allorisma granosus*, *A. subcuneata*, *Pinna peracuta*, *Productus semireticulatus*, *Nautilus capax*, and *Fusulina cylindrica*. These above named are the principal fossils observed and are typical of the Kansas Permian, but most of them I have also obtained from known upper coal measure rocks of Missouri.

The highest coal of the series was observed in Greenwood county, where Wolf branch runs into Spring ereek. Its position is probably about the base of the Permian or top of the true upper coal measures. Its associated rocks are as follows:

1. 2 feet grayish-brown limestone.
2. 1 " shelly bluish-gray limestone.
3. 2½ " blue clay shales.
4. 3 inches shaly coal.
5. 2½ " soft coal. poor quality.
6. 33 feet of blue clay shales.

About the year 1867 the magnesian limestones of Kansas began ta attract attention. The first was exported from Junction City, was cut into shape by means of a common saw and shipped to Kansas City and other places. It proved too weak, and other quarries were sought. From Maryville, Kansas, it was brought to St. Joseph, Mo., in large quantities, and used in the bridge piers at that place. Some of this was too soft, but the general character of the Maryville rock is good. At present there are numerous quarries in the valley of the Cottonwood from Cottonwood Falls to Florence, and rock of an excellent quality is exported.

Good quarries could be opened nearly everywhere in the "Flint Hills," and the hillsides west of Greenfield are everywhere strewn with large tumbling masses of rock ready to be used. From the head of Ivanpah creek the rock has been hauled in wagons 20 miles to build the court-house at Eureka. On Cedar creek, Cowley county, are exposures of very thick layers, and good quarries have been opened near Winfield.

The buff and drab limestones are found everywhere in Cowley county east of the Arkansas and Walnut rivers, and are either on the surface or within four feet of it everywhere on the uplands; but are generally deficient in organic remains, and many of the beds afford a poor building-stone. North of Winfield, on the highlands, the strata afford quartz geodes.

Throughout Butler county the rocks are similar in character to those of Cowley, and we also find that in passing west from the Permian Mountains ("Flint Hills") good specimens of fossils are very rare. Between Walnut river and Whitewater the rock is often upon the surface: west of Whitewater deeper soils cover it, and the wells reveal blue shale beds.

Springs of water are often rare, but on the hills of Cowley Co. water is generally reached at about 60 feet depth, and, passing to the valley below, we find good springs at a corresponding horizon with the bottom of these wells. The Permian ridge includes about 500 feet of Permian strata.

Assuming the westerly dip to be regular, we probably have 1,000 feet additional thickness of higher strata in passing across Butler county: so we may be safe in assuming 1,500 feet of Permian beds in southern Kansas.

In these counties it is the NEWEST rock below the Quartenary. No other rocks of later formation than the Permian may be found in either Cowley, Butler or Greenwood.

The PERMIAN of Kansas rests CONFORMABLY on the COAL MEASURES, and there is no decided line of separation between the two. Certain strata can be grouped together, as can certain other strata of other formations. The only marked difference is this:—Passing a certain horizon in the ascending series, we find the rocks to be all of a drab, buff or cream color, and the limestones more impure and break with a rougher fracture; also, when jointed vertically, the angle more nearly approaches a right angle, whereas the coal measure limestones are jointed into more acute rhomboidal blocks.

The group of the Permian Mountains forms an interesting study, the strata are easily traced, and the scenery afforded is very fine and the views very extensive.

After writing the above, I have made sections of the Permian further north, chiefly among upper strata. At Manhattan I observed the following:

1. $4\frac{1}{2}$ feet of drab limestone in layers, chiefly 12 to 16 inches, used extensively in railroad masonry, for which purpose it is taken some distance on line of Kansas Pacific railway.
2. 30 " shaly slope.
3. $3\frac{1}{2}$ " rather uniformly fine grained limestone; lower bed mottled drab, compact, and somewhat of a splintry fracture; rather uncommon in this formation.
4. 170 " to base of hill. chiefly of shales; a bed of red shale half-way down.

No. 1 is full of *Fusulina cylindrica*, which sometimes is absent, leaving the rock full of small cells.

On central branch Union Pacific railway these limestones are extensively quarried for 20 miles from Frankfort to Waterville. The general appearance of the rock is drab or buff inclining (near the river) to a bluish-drab; but few fossils can be obtained. A Fusulina limestone abounds on the higher hills which very much resembles that of Manhattan; it is also generally cherty. Red shaly beds appear at Blue Rapids, and these shale beds often contain quite extensive deposits of gypsum. The quantity of this is such as to keep actively at work a plaster mill. A general section near Blue Rapids is as follows:

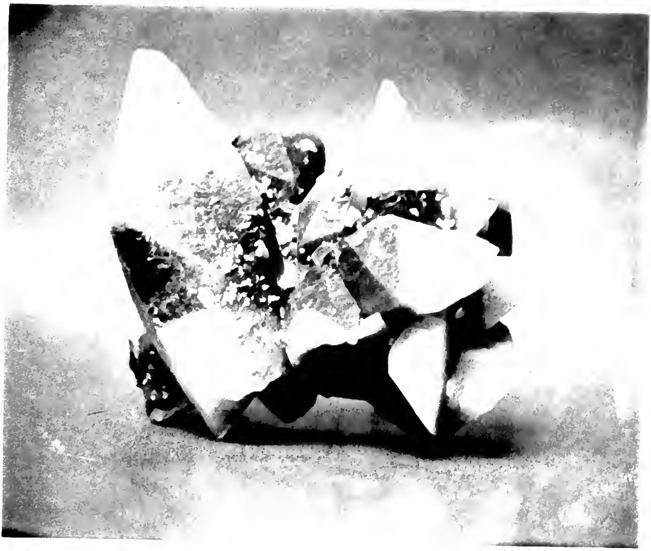
1. Limestone on hilltop.
2. 100 feet shales; some chert seen on slopes.
3. 4 " of magnesian limestone in layers of 4 to 12 inches.
4. 15 " of shales with small geodes.
5. 4 " of limestone in 16-inch layers, whitish drab, with blue chert between the layers.
6. 30 " shales.
7. $1\frac{1}{2}$ " building-stone, coarsely cellular.
8. 30 " shales, lower part red, with gypsum.
9. 4 " limestone.
10. 4 " nodular shales.

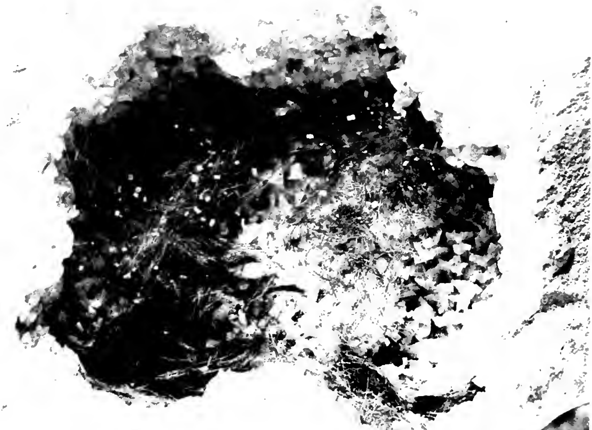
Meekella striato-costata is found in upper beds; in the lower we find *Productus semireticulatus*, *Chonetes granulifera*, *Eumicrotis hawni*, *Hemipronites crenistria*, and *Fusulina*.

Borings at Blue Rapids reveal gypsum and a thin seam of coal. At Waterville, five miles west, the rock seen on hilltop at Blue Rapids is low in the hills. The same rock, a buff limestone, is seen at Maryville, 14 miles north.

The limestones at Maryville, the county seat of Marshall Co., are of a buff color and quite soft, with occasional specimens of *Allorisma subcuneata*. The quarries in the valley of the Cottonwood, Chase county, contain about 6 feet of very good building stone of closer texture and apparently better than the Manhattan rock. The associated shale beds abound in fine fossils, including *Prod. semireticulatus*, *Hemp. crenistria*, a large variety of *Chonetes granulifera*, and *Athyris subtilita*, *Archæocedaris*, and a Crinoid. Similar fossils can also be obtained at Florence, where the upper limestones are quite flaggy. The lower limestones here are also quite cherty.

At Marion Centre, Marion county, we find higher strata, with but few fossils. The upper layers form good flags, the lower are much used for building. *Aviculopecten occidentalis* and *Fusulina cylindrica* were the only fossils seen.





On the occurrence of Millerite in St. Louis.

BY ALEXANDER V. LEONHARD.

[Read October, 1882.]

The Millerite is the mineralogical specialty of St. Louis; in no other place has it been found in such abundance and in such beautiful development. The city of St. Louis is underlaid by extensive beds of limestone which belong to the upper part of the subcarboniferous period, and have been termed by Swallow as St. Louis Limestone. A number of quarries are worked inside the city limits exposing to the eye 40–80 feet of the rock strata. In these quarries a great many cavities have been found, ranging in size from less than 1 inch to 1 foot and more in diameter, partially filled with different minerals. In some quarries certain layers of the limestone contain the largest number of these geodes, but they have been found in all the different parts of the formation. Their greater frequency in the so-called "hydraulic beds" —by which name the gray-colored, softer and porous strata of the limestone are designated by the quarrymen—is evidently due to the fact that the solutions depositing the minerals could more easily percolate through these porous strata than through the other parts of the St. Louis Limestone, which are more dense and compact. The following minerals have been found in these cavities: CALCITE, DOLOMITE, FLUORITE, MILLERITE and SPHALERITE, which form the older series of the minerals, each of them being frequently deposited on the walls of the cavity directly; while a younger series of minerals—ANHYDRITE, SELENITE, BARITE, STRONTIANITE, and PYRITE—are nearly always formed after and on some of those older minerals.

The Sphalerite is only very rarely met with, and never in connection with Millerite. The Millerite has been formed before, during and after the deposition of the older minerals, of Calcite, Dolomite, and Fluorite. I have never seen Millerite deposited *on* any of the younger minerals. Barite, Strontianite, and Pyrite, when in connection with it, are always formed later. Anhydrite and Selenite are found in the same cavities as the Millerite, but I have not remarked a direct connection between them.

The Millerite occurs in a variety of forms. The purest crystalline variety forms thin, long, needle-like prisms, many of them uniting in one point at the wall of the cavity or on calcite-crystals, and radiating from this point into the cavity. They are 1–6″ long, very elastic, of high metallic lustre, and brass-yellow color. Under the microscope these "needles" show a six-sided prism, striped longitudinally and terminated by the rhombohedral faces. Those examined by me varied in thickness from 0.03–0.05 mm. If pressed with a hard instrument these prisms divided into numerous fibres, each of which showed the same prismatic form. The thickness of these fibres was 0.0007–0.0015 mm. The angie between the face of the rhombohedron and the prism — average of many measurements — is 110° 36′. These crystals are often enclosed in crystals of calcite, sometimes in such amounts as to render the calcite opaque.

The Millerite is also found in aggregations, up to 2 inches long and to ¼ inch thick, formed by many prisms adhering to each other. These spear-like forms are usually round, sometimes flattened, and pointed at both ends. They occasionally traverse crystals of Calcite, or are enclosed at one end in crystals of Fluorite. These forms have not the high metallic lustre of the needle-like crystals, but are mostly dull and of darker color.

Most frequently the Millerite appears in very thin thread-like forms which are irregularly bent and interwoven. The thickness of these prisms is the same as of those fibres composing the straight needle-like prisms. The thin threads, of dark green color, are often so closely interwoven as to resemble very thick spider-web, and, in that form, lie over crystals of Fluorite, Calcite, or Dolomite. More frequently they form bunches looking like bunches of hair, which sometimes fill the whole interior of cavities that are lined with some of the other minerals. Small crystals of Dolomite are often attached to these forms; also little rounded aggregations of Barite and Strontianite, which are always in an advanced state of decomposition, snowy-white, crumbling between the fingers.

Minute crystals of Pyrite rarely surround these prisms of Millerite. The Pyrite as seen under the microscope is in cubical form, and shows plainly the striation of the faces. The Millerite perforates it, sometimes going through the centres of opposite faces, but mostly without regard to symmetry.

The composition of the Millerite in St. Louis, as shown by an analysis of C. Luedeking, of Washington University, and several determinations made by myself, varies not much from the theoretical composition of Nickelsulphide, viz., 64.45 p. ct. of Nickel and 35.55 p. ct. of Sulphur. The only admixture is Iron, the amount of which varies from 0.8 p. ct. in some needle-like crystals to 2.65 p. ct. in some of the spear-like forms.

The specific gravity of the Millerite—average of many determinations—is 5.028.

The annexed Plates show different forms of Millerite in their natural size. They are printed from photographic views by the artotype process, in the establishment of R. Bennecke. The upper figure Plate I. shows a Calcite crystal nicely developed on both ends, pierced by a spear of Millerite. Besides, the crystal encloses a very large number of straight needles of Millerite which can be plainly seen in the crystal, and are indicated on the figure by faint, nearly horizontal, lines. The specimen is quite unique, and is in possession of Dr. Hambach. The lower figure shows a cavity in the limestone. On the left side rises a tuft of straight needle-like crystals of Millerite, and on the right side a thick stem of it. This "spear," before broken, was attached with both ends to the walls of the cavity, and both ends are surrounded by thick bunches of the same mineral.

On Plate II. the upper figure represents a group of Calcite crystals. The middle part of each crystal is of dark, nearly black, color, caused by minute particles, probably of Millerite, while both ends of the crystal are white. On the Calcite crystals are deposited small flakes of Barite. The lower figure shows the interior of a cavity lined with pink-colored Dolomite crystals, filled with irregular bunches of thin, thread-like Millerite.

The originals of the last three figures are in the collection of Washington University, St. Louis.

The mean and extreme daily Temperatures in St. Louis during forty seven years, as calculated from daily observations,

By Dr. George Engelmann.

Half a century has passed since I began to study the meteorology and climatology of this neighborhood, and since the year 1836 I have made regular meteorological observations, first on temperature, the winds and the condition of the sky, and soon afterwards on atmospheric pressure, rainfall and humidity.

I give here the results of my thermometrical observations, which I consider as the most important and most interesting of the series. They comprise, to be sure, only forty-seven years, and I might have waited until at least half a century was completed; but the results would scarcely have been different, and the task then perhaps problematical of accomplishment.

The observations were made within the city of St. Louis, and can thus not claim precision for this whole region. St. Louis, to be sure, was, when they commenced, a small town of perhaps 15,000 inhabitants, while now, at their completion, it is a large city of probably 400,000, with the necessary accompaniment of brick and stone, and especially with the smoke of thousands of chimneys, furnaces and factories, and the almost total absence of verdure. It has been held by some, that these influences had little effect on temperature, but that brisk breezes would soon dispel smoke and equalize temperature. This, however, is not quite so, and direct thermometrical comparisons prove that the extreme temperatures, and, remarkably enough, even the extreme heat, are less marked in the city than in the country, and that the mean temperature is higher in the city than in the country (Trans., vol. ii., p. 70); but, aside from instrumental observation, the state of the vegetation proves it every spring and fall, when we find in our city gardens the plants uninjured on mornings when in the country they have suffered from late or early frosts.

St. Louis lies very nearly in the centre of the Mississippi Valley, 600 miles north of the Gulf of Mexico and just as far south of Lake Superior, about 500 miles west of the Alleghanies and 800 miles east of the Rocky Mountains; its Washington University, one mile west of the river, lies in Lat. 38° 38′ 03″ and Long. 90° 12′ 15″; the low-water mark of the Mississippi is 379 feet above the Gulf, and the foot of Market street (City Directrix) is 413 feet above the same.

My observations were made in the first twelve years on the south-east corner of Second and Chestnut streets, only two blocks from the river and 75 feet above low-water mark of 1863; for the next 22 years on the south-west corner of Fifth and Elm streets, five blocks from the river and 110 feet above low-water mark; and for the last 13 years on the north-west corner of Thirtieth and Locust streets, two miles from the river and 177 feet above low-water mark. When I was absent from the city Dr. A. Wislizenus and lately Mr. B. D. Kribben have kindly filled the gaps.

My instruments were at first such as could then be obtained here; soon I imported correct thermometers from Europe, and for nearly 40 years I used those made by Jas. Green, then of Baltimore, and soon afterwards of New York.

For many years the observations were made at different periods of the day, and especially at hours when the extremes might be expected to occur, viz. at sunrise and at 3 P.M.; and the maximums and minimums were selected from all of them, often eight in a day, at whatever hour of the day they were found. Differential thermometers were observed only since the last 12 years. Thus I may not always have noted the absolute extremes of each day, and my tables can claim only approximate reliability; I give them for what they may be worth, but I can assure my readers that they furnish a record elaborated with zeal, conscientiousness, care and assiduity, and for a length of time such as probably few others, if any, exist in this valley.

The arrangement of the tables explains itself. The first two columns represent the means of the 47 minimum and of the 47 maximum observations made on each day of the year, and the third column the mean calculated from the two former. The next "Min." column gives the lowest and the "Max." column the highest temperature ever observed on that day; the column of years next to these gives the year in which these extremes did occur. The last column represents a supposed—or estimated—true mean for the day after eliminating excessive extremes.

The year has been divided into 73 periods of 5 days each, the means of which are printed in full-face type, to distinguish them. It will be seen, however, that the means of these periods do not progress, rise and fall, much more evenly than the single daily means; compare, e.g., the mean of Jan. 31st to Feb. 4th. which is so much lower than the mean of the foregoing or the following five days that one might suspect a regular and normal decline of temperature in these days, and not a mere accident.

A few facts must strike every one who examines the tables. The first is. that a time even as long as 47 years fails to give us anything approaching absolute and reliable means; and we come to the painful conclusion, that observations even continued for double that time, or for a century, may not yet obtain that desirable object. It seems that the excessive extremes of one or of a few days such as we often observe in our climate of extremes, especially in the winter season, will influence—or, I may say, vitiate—the means of a long series of observations; and the question with me arises. whether such extremes ought not to be eliminated from the series, and thus truer means be obtained. At the same time we may justly be astonished that from such heterogeneous data so much order and system result—which gives us hope that we cannot be quite on the wrong track.

Another fact, which strikes us in looking over the tables, is that the mean temperatures do not increase and decrease evenly, but sometimes quite rapidly, and at other times they may become almost stationary for a time. These points come out most strikingly on a diagram which embodies the essential parts of the results and shows the daily progress of the temperature. Thus we find very little change from the middle of December to the first part of February, though the temperature proves to be lowest from January 4th to 13th: then we notice a rapid rise from Feb. 6th to 20th, a slower rise to the middle of March, then a rapid one to the end of the month; in the forepart of April a slow and after the middle of that month a very marked one; then follows a tolerably even, at last quite slow, rise to July 9th, when between this date and the 18th the greatest elevation of the curve is obtained. After that the mean temperature falls slowly to the middle of August, followed by a more rapid decline to the end of September; after a slight pause in the first week in October, a more rapid fall takes place for the following two weeks and a slighter one in the two weeks succeeding them. After that the temperature sinks rapidly to about Dec. 10th, from which time till the beginning of February the changes are not very marked.

The mean temperature of April 17th to 19th and from October 12th to 17th correspond with the mean of the year.

The tables, and still more distinctly the diagram, show us also that the extreme highest and lowest temperatures diverge most in winter and least in summer, and that their values are much more variable in the former than in the latter season. The possibilities of range from the middle of December to the middle of March are 80 to 95 degrees, while in June and July they amount only to 40 or 45 degrees.

The same law is found when we compare the actually observed lowest minimum and highest maximum of every month; their divergence is greatest in January, and least, not much more than half, in July.

	Min.	Max.	Range.		Min.	Max.	Range.
January......	−22.5	72.0	94.5	July	53.0	104.0	51.0
February	−15.0	76.0	91.0	August	45.0	104.0	59.0
March	0.0	86.0	86.0	September ...	35.0	102.0	67.0
April	18.0	99.0	81.0	October	19.5	91 0	71.5
May	29.0	97 5	68.5	November....	— 0.5	81.5	82.0
June.........	43.0	101.5	58.5	December....	−19.5	72.5	92.0

Nearly the reverse is the case—i.e. the range in winter is much smaller than that in summer—if we compare the difference of the average daily minima and maxima for each month:

January..	13.27	April.....	18.29	July	18.24	October ..	18.00
February.	14.72	May......	18.77	August...	17.75	November	14.06
March....	16.40	June	18.14	September	19.05	December.	11.97

The range, it will be seen, is, on the whole, least in the cooler and greatest in the warmer months of the year; but this difference is not due to the lower or higher temperatures of those months, for it will be seen that in December the range is the smallest (smaller than in January) and in September greatest (greater than in July). This variation in the range of maxima and minima is undoubtedly owing to the condition of the sky in the different months. Gloomy weather prevails in the beginning of winter, and a clear sky with abundant evaporation, and thus a reduction of night temperature, in the autumn. The little table can give us an indication of the prevailing weather in the different months. Thus the difference, and its cause, the clearness of the sky, rises from December gradually till May, falls a little in June and July and more in August, rises to its highest point in September, is yet high in October and then falls rapidly till December, to rise again in January.

The temperature of our continental locality shows a great difference from that of the western coast of Europe; as a convenient example we may refer to the temperature of London. Their winters are warmer from the latter part of November until the beginning of March, and their summers much cooler from this period to the latter third of November; and the mean is much higher here.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Whole year.
St. Louis..	31.8	35.4	43.7	56.2	66.3	74.7	79.2	76.8	69.0	56.1	42.8	33.4	55.4
London...	37.2	39.3	42.7	48.1	54.5	60.8	63.6	62.0	57.6	50.4	42.7	39.7	49.9
Difference.	+5.4	+3.9	−1.0	−8.1	−11.8	−13.9	−15.6	−14.8	−11.4	−5.7	−0.1	+6.3	−5.5

MEAN AND EXTREME TEMPERATURES IN ST. LOUIS FROM 1836 to 1882.

1836-1882	Mean Values for each Day. Min.	Max.	Mean.	Extreme Maxima and Minima observed on each Day of the Year. Min.	Year.	Max.	Year.	Supposed true Mean.
Jan. 1	23.55	36.77	30.16	−22.5	1864	68.0	1876	31.5
2	25.35	37.97	31.66	−13.0	1879	65.5	1855	31,3
3	25.54	38.55	32.04	−15.5	"	66.5	187[illegible], 1880	31.0
4	23.95	35.82	29.88	− 6.0	"	63.5	1880	30.5
5	23.45	39.22	31.33	− 8.5	1864	62.0	1876	30.2
	24.36	**37.66**	**31.01**	**−13.1**		**65.1**		**30.9**
6	23.76	37.63	30.69	− 9.0	1879	64.0	1880	30.0
7	22.33	33.95	28.14	− 1.0	1881	64.0	1839	29.4
8	22.75	34.61	28.68	− 6.0	1877	68.0	1876	29.0
9	22.65	35.48	29.06	−18.0	1875	65.5	"	29.0
10	22.67	34.82	28.74	−11.0	1881	70.0	1839	29.5
	22.83	**35.29**	**29.06**	**− 9.0**		**66.3**		**29.4**
11	25.42	39.20	32.31	− 1.0	1881	71.0	1839	30.0
12	26.69	39.27	32.98	−− 2.0	1852	65.0	1863	30.2
13	24.61	36.81	30.71	0.0	"	59.0	"	30.6
14	25.61	38.11	31.86	−12.5	1881	64.0	1848	31.0
15	26.71	39.67	33.19	− 2.5	1875	66.0	1847	31.4
	25.80	**38.61**	**32.21**	**− 6 0**		**65.0**		**30.6**
16	24.03	36.27	30.15	2.0	1841	63.0	1845	31.8
17	21.09	34.27	27.68	−11.0	"	64.0	1842	32.0
18	21.65	34.32	27.98	−12.5	1857	66.0	"	32.0
19	23.63	38.09	30.86	−12.0	1852	61.0	1843	32,0
20	27.83	39.54	33.68	− 1.5	1866	64.0	"	32.0
	23.64	**36.49**	**30.07**	**− 7.0**		**63.6**		**31.9**
21	25.97	38.79	32.38	− 3.0	1854	67.0	1843	32.0
22	23.84	39.19	31.52	− 2.5	1857	62.0	1858	32.0
23	24.63	38.36	31.49	0.0	1854	62.0	1864	32.0
24	25.57	39.64	32.60	2.0	1873	65.0	1860	32.2
25	27.26	41.63	34.44	− 5 5	1840	65.0	1864	32.4
	25.45	**39.52**	**32.48**	**− 1.8**		**64.2**		**32.1**

1836-1882	Mean Value for each Day. Min.	Max.	Mean.	Extreme Maxima and Minima observed on each Day of the Year. Min.	Year.	Max.	Year.	Supposed true Mean
Jan. 26	26.76	40.36	33.56	1.0	1865	71.5	1843	32.6
27	26.96	39.53	33.24	— 0.5	1873	72.0	1864	32.6
28	24.85	39.15	32.00	— 6.5	"	67.0	"	32.7
29	25.32	39 30	32.31	—23.0	"	64.5	1852	32.8
30	24.79	41.09	32.94	— 2.0	1856	64.5	1842	32.8
	25.73	**39.88**	**32.81**	**— 6.2**		**67.8**		**32.7**
31	24.96	38.20	31.58	2.0	1875	65.5	1877	32.8
Feb. 1	23 32	37.20	30.26	— 8.5	1836	70.0	1854	32.8
2	23.55	35.77	29.66	— 3.5	1873	56.0	1846	32.9
3	21.71	35.72	28.72	—15.0	1856	62.5	1852	32.9
4	22.01	36.51	29.26	—11.0	"	61.0	1837	33.0
	23.11	**36.68**	**29.89**	**— 7.2**		**63.0**		**32.9**
5	24.67	39 29	31.98	— 3.5	1856	61.0	1837	33.0
6	26.00	41 04	33.52	3.0	1843	67.0	1855	33.1
7	26.08	41.19	33.63	— 3.5	1872, 1875	65.0	1851	33.1
8	24.74	39.98	32.36	2.0	1842	66.0	1847	33.2
9	24.37	40.05	32.21	— 5.0	1875	72.0	1876	33.3
	25.17	**40.31**	**32.47**	**— 1.4**		**66.2**		**33.1**
10	25.92	41.56	33.74	1.0	1841	73.0	1876	33.5
11	29.98	43.93	36.95	2.0	"	73.0	1845	33.7
12	29.00	43.44	36.22	2.0	"	70.5	1882	33.9
13	29.06	40.41	34.73	4.5	1838	69.0	1867	34.0
14	24.71	39.38	32.04	— 3.5	1866	61.0	1857	34.1
	27.73	**41.74**	**34.73**	**1.2**		**69.9**		**33.8**
15	26.53	41.09	33.81	— 9.5	1866	68.0	1848	34.2
16	26.07	42.59	34.33	— 5.0	"	63.5	1857	34.4
17	28.03	41.18	34.60	— 4.0	1838	74.5	"	34.6
18	28.05	42.39	35.22	— 2.5	1849	65.5	1873	34.8
19	30.26	44.57	37.41	5.0	1838	76.0	1859	35.0
	27.79	**42.36**	**35.07**	**— 3.2**		**69.5**		**34.6**
20	31.83	45.80	38.81	— 3.5	1870	68.5	1850	35.5
21	30.33	45.27	37.80	— 4.5	1838	68.0	1836	36.0
22	31.82	46.97	39.39	1.5	1858	68.5	1861	36.5
23	30.11	44.71	37.41	0.0	"	69.5	1851	37.0
24	29.38	45.91	37.64	6.0	1873	69.0	1880	37.5
	30.69	**45.73**	**38.21**	**— 0.1**		**68.7**		**36.5**
25	31.02	46.05	38.53	7.0	1855	67.0	1876	38.0
26	31.68	48.91	40.29	2.0	1846	68.5	1880	38.5
27	30.58	45.46	38.02	5.0	1836	73.5	1876	38.7
28	30.47	47.02	38.74	10.5	1836, 1869	74.0	1861	39.0
Mar. 1	32.35	49.02	40.68	10.0	1843	79.5	"	39.2
	31.22	**47.29**	**39.25**	**6.9**		**72.5**		**38.7**
2	31.36	45.97	38.66	8.0	1843	76.0	1861	39.8
3	29.29	43.89	36.59	0.0	1848	78.0	1842	40.0
4	29.50	44.54	37.02	6.0	1875	75.5	1882	40.5
5	30.62	47.38	39.00	8.0	1848	71.0	1855	40.8
6	34.94	49 20	42.07	4.5	1869	76.5	1860	41.0
	31.14	**46.19**	**38.67**	**5.3**		**75.4**		**40.4**
7	34.88	51.60	43.24	10.5	1857	77.0	1853, 1879	41.2
8	34.49	50.31	42.40	13.5	1875	77.0	1879	41.4
9	35.01	48.18	41.59	6.0	1877	78.5	1842	41.6
10	33.22	49.52	41.37	10.0	1856	79.5	1279	41.8
11	34 55	49.67	42.11	7.0	1836	69.0	1848	42.0
	34.43	**49.85**	**42.14**	**7.4**		**76.0**		**41.6**

1836-1882	Mean Value for each Day.			Extreme Maxina and Minima observed for each Day of the Year.				Sup-posed true Mean
	Min.	Max.	Mean.	Min.	Year.	Max.	Year.	Mean
Mar 12	34.82	50.86	42.84	11.5	1836, 1857	71.0	1839, 1861	42.2
13	34.24	50.64	42.44	5.0	1867	75.0	1850	42.4
14	34.51	50.55	42.53	1.0	"	76.5	1875	42.5
15	33.87	48.89	41.38	7.5	1870	80.5	1854	42.6
16	34.14	50.03	42.08	9.0	1843	77.5	1868	42.8
	34.31	**50.19**	**42.25**	**6.8**		**76.1**		**42.5**
17	33.49	52.07	42.78	10.5	1879	79.0	1842	43.0
18	34.86	52.32	43.59	15.0	"	84.0	"	43.5
19	36.09	54.82	45.45	18.5	1875	84.0	"	44.0
20	36.91	52.52	44.71	14.0	1855	84.0	"	44.5
21	34.21	50.68	42.44	7.0	1876	76.0	1878	44.8
	35.11	**52.48**	**43.79**	**13.0**		**81.4**		**43.9**
22	35.56	54.04	44.80	13.0	1843	76.0	1857	45.0
23	37.09	55.48	46.28	7.5	"	82.5	1868	45.2
24	36.90	54.30	45.60	12.0	"	83.0	1842	45.4
25	37.21	53.76	45.48	13.0	"	82.5	1852	45.6
26	37.69	54.92	46.30	13.5	1873	78.5	1838	46.0
	36.89	**54.50**	**45.69**	**11.8**		**80.5**		**45.4**
27	39.16	56.81	47.98	23.5	1850	85.0	1838	46.5
28	39.77	57.31	48.54	18.0	1855	83.5	1879	47.0
29	40.42	58.31	49.36	23.5	1876	86.0	1842	47.5
30	41.07	57.91	49.49	28.0	"	84.0	1838	48.0
31	40.35	57.34	48.84	25.5	1856	84.0	"	48.5
	40.15	**57.53**	**48.84**	**23.7**		**84.5**		**47.5**
Apr. 1	39.70	57.25	48.47	24.0	1881	81.5	1882	49.5
2	40.92	61.12	51.02	24.0	"	85.0	"	50.0
3	44.66	62.44	53.55	24.5	1879	86.0	"	51.0
4	44.00	59.67	51.83	23.0	"	85.0	"	51.5
5	42.79	60.82	51.80	22.5	1857	88.5	1871	52.0
	42.41	**60.26**	**51.33**	**23.6**		**85.2**		**50.8**
6	43.61	62.89	53.25	18.0	1857	89.0	1871	52.5
7	44.77	63.98	54.37	29.0	1880	85.5	1860	53.0
8	45.59	60.96	53.28	24.0	1845	82.5	1836	53.0
9	43.84	61.86	52.85	27.0	1857	84.0	1844	53.2
10	45.07	61.94	53.50	28.5	1836, 1874	87.0	"	53.4
	44.57	**62.33**	**53.45**	**25.3**		**85.6**		**53.0**
11	43.81	62.53	53.17	27.0	1857	83.0	1842	53.6
12	45.35	62.44	53.89	26.0	"	84 0	1856	53.8
13	45.33	63.59	54.46	32.0	"	88.0	1845	54.0
14	45.03	63 26	54.14	28.5	"	84.0	"	54.2
15	44.52	62.02	53.27	23.0	1850	82.0	1856	54.4
	44 81	**62.77**	**53.79**	**27.3**		**84.2**		**54.0**
16	45.62	62.26	53.94	26.5	1875	91.0	1845	54.6
17	45.11	64.55	54.83	20.5	"	93.0	1855	55.0
18	45.78	64.34	55.06	26.0	"	99.0	"	56.0
19	47.20	66.47	56.83	29.0	1857	83.0	1847	57.0
20	48.47	67.92	58.19	34.0	"	85.0	1836	58.0
	46.43	**65.11**	**55.77**	**27.2**		**90.2**		**56.1**
21	49 76	69.01	59.38	36.0	1857, 1875	85.0	1867	59.0
22	51.37	69.70	60.53	31.5	1875	87.5	1842	60.0
23	49.88	69.90	59.89	31.5	1865	87.0	1842, 1854	60.0
24	50.24	68.92	59.58	34.0	1874	88.5	1854	60.0
25	51.89	70.82	61.35	33.5	1874, 1875	93.0	1843, 1855	60.0
	50.63	**69.67**	**60.15**	**33.3**		**88.2**		**59.8**

1836-1882	Mean Values for each Day. Min.	Max.	Mean.	Extreme Maxima and Minima observed on each Day of the Year. Min.	Year.	Max.	Year.	Supposed true Mean
Ap. 26	51.20	70.53	60.86	33.5	1873	88.0	1872	60.0
27	50.63	69.98	60.30	37.0	1857	93.0	1838	60.0
28	51.21	68.71	59.96	34.0	1854	83.5	1845	60.0
29	50.87	69.15	60.01	33.0	1874	89.5	"	60.0
30	50.68	69.07	59.87	32.0	1877	92.5	1855	60.0
	50.92	**69.49**	**60.20**	**33.9**		**89.3**		**60.0**
May 1	50.53	69.72	60.12	35.5	1877	91.5	1836	60.0
2	51.06	68.34	59.70	29.0	1851	87.0	"	60.2
3	51.05	69.67	60.36	38.0	1841	88.5	1849	60.4
4	53.60	71.04	62.32	37.0	1877	89.0	1860	61.0
5	53.72	71.88	62.80	37.0	1851	91.5	"	61.4
	51.99	**70.13**	**61.06**	**35.3**		**89.5**		**60.6**
6	52.85	71.47	62.16	37.5	1863	88.0	1872	61.8
7	53.77	73.49	63.63	35.0	1867	88.0	"	62.0
8	54.05	72.56	63.30	38.0	1855	88.0	"	62.5
9	54.40	73.21	63.80	39.0	"	88.0	"	63.0
10	53.37	73.16	63.26	40.0	1838, 1871	89.5	1844, 1863	63.5
	53.68	**72.78**	**63.23**	**37.9**		**88.3**		**62.5**
11	54.12	72.78	63.45	39.0	1864	91.5	1844	64.0
12	55.17	74.79	64.98	39.5	1857	91.5	1836	64.5
13	56.34	75.17	65.75	41.5	1878	90.0	1862	65.0
14	56.72	74.75	65.73	42.0	"	97.5	1836	65.5
15	55.61	75.53	65.57	40.5	"	93.0	"	66.0
	55.59	**74.60**	**65.05**	**40.5**		**92.7**		**65.0**
16	56.73	75.52	66.12	40.0	1837, 1875	92.0	1851	66.5
17	56.01	73.47	64.74	42.0	1857	91.0	1853	67.0
18	55.19	75.27	65.23	42.0	"	87.0	1836, 1870	67.5
19	57.24	77.30	67.27	43.0	1853	89.5	1871	68.0
20	57.61	77.34	67.47	42.0	1852	90.5	1836	68.2
	56.55	**75.78**	**66.17**	**41.8**		**90.0**		**67.4**
21	58.76	76.31	67.53	43.0	1857	96.0	1870	68.4
22	58.53	78.02	68.27	40.0	1838	97.0	"	68.6
23	59.26	77.68	68.47	44.0	1867, 1876	90.0	1839, 1856	68.8
24	59.66	78.80	69.23	45.0	1851	92.5	1873, 1879	69.0
25	60.21	77.40	68.80	44.0	1845	93.0	1860	69.5
	59.28	**77.64**	**68.46**	**43.2**		**93.7**		**68.8**
26	60.46	81.00	70.73	48.0	1853	93.0	1860	70.0
27	60.33	79.37	69.85	48.0	"	94.0	1874	70.2
28	60.46	80.59	70.52	45.0	1838	91.0	1848, 1851	70.4
29	61.08	79.24	70.16	44.0	1866	91.0	1852, 1879	70.6
30	61.68	79.94	70.81	44.0	1845	90.0	1841, 1854	70.8
	60.80	**80.02**	**70.41**	**45.8**		**91.8**		**70.4**
31	62.14	79.25	70.69	52.0	1856	97.0	1871	71.0
June 1	61.49	79.78	70.63	49.0	1843	91.0	1845, 1852	71.0
2	62.39	80.70	71.54	49.0	1838	94.0	1852	71.2
3	62.44	80.12	71.28	47.5	1879	93.0	1856	71.4
4	62.05	79.06	70.55	44.0	1859	94.0	1841	71.6
	62.10	**79.78**	**70.94**	**49.3**		**93.8**		**71.2**
5	61.36	79.45	70.40	43.0	1839	93.0	1871	71.8
6	62.57	81.88	72.22	43.0	1838	93.0	1836, 1874	72.0
7	62.18	81.34	71.73	50.0	1854	95.0	1874	72.2
8	63.83	81.95	72.89	49.0	"	96.0	1836	72.4
9	63.62	81.18	72.40	51.5	1852, 1877	99.5	"	72.6
	62.71	**81.16**	**71.93**	**47.3**		**95.3**		**72.2**

1836-1882	Mean Values for each Day.			Extreme Maxima and Minima observed on each Day of the Year.				Supposed true Mean
	Min.	Max.	Mean.	Min.	Year.	Max.	Year.	
Jun. 10	62.65	81.90	72.27	46.5	1877	97.5	1836	72.8
11	61.90	79.38	70.64	45.0	1842	94.0	1841	73.0
12	63.32	81.59	72.45	50.0	1858	94.5	1853	73.2
13	64.87	83.82	74.34	50.0	"	94.5	"	73.4
14	65.01	83.84	74.42	51.0	1856	96.0	1879	73.6
	63.55	**82.10**	**72.82**	**48.5**		**95.3**		**73.2**
15	65.11	83.79	74.45	49.0	1869	96.5	1868	73.8
16	65.26	82.32	73.79	53.0	1841	98.5	"	74.0
17	65.56	82.60	74.08	51.5	1876	98.5	"	74.3
18	65.78	83.97	74.87	49.5	"	99.0	"	74.6
19	65.59	84.37	74.98	52.0	1866	96.0	1853, 1869	74.8
	65.46	**83.41**	**74.43**	**51.0**		**97.7**		**74.3**
20	65.92	83.96	74.94	52.0	1862	98.0	1861	75.0
21	65.57	83.52	74.54	49.0	1863	97.0	1853	75.3
22	65.64	85.82	75.73	50.0	1868	99.0	1871	75.6
23	67.06	84.58	75.82	53.0	"	101.5	"	76.0
24	66.91	85.11	76.01	55.5	1853	97.5	1870	76.5
	66.22	**84.60**	**75.41**	**51.9**		**98.6**		**75.7**
25	68.13	86.54	77.33	56.0	1852	98.0	1870, 1882	77.0
26	68.73	87.88	78.30	55.0	1865	98.5	1870	77.5
27	70.26	87.21	78.73	59.0	1836	97.0	1854	78.0
28	69.36	87.48	78.42	55.5	1866	100.0	1870	78.0
29	69.26	86.08	77.67	51.0	"	101.5	"	78.0
	69.15	**87.04**	**78.09**	**55.3**		**99.0**		**77.7**
30	69.23	86.95	78.09	56.0	1871	101.5	1870	78.0
July 1	68.39	85.91	77.15	54.0	1851	98.0	1854	78.0
2	68.06	85.60	76.83	54.0	1861	98.5	1858	78.0
3	68.42	87.10	77.76	56.0	1857	99.5	1856	78.1
4	68.71	87.89	78.30	53.0	1859	100.5	1868	78.2
	68.56	**86.69**	**77.62**	**54.6**		**99.6**		**78.1**
5	69.24	87.39	78.32	56.5	1882	98.5	1870	78.3
6	70.11	88.05	79.08	54.0	1842	97.0	1868	78.6
7	70.20	87.84	79.02	58.0	"	98.0	1874	79.0
8	70.55	87.97	79.26	58.0	1870	97.0	1854, 1879	79.0
9	71.05	89.15	80.10	57.0	1842	99.0	1858	79.2
	70.23	**88.08**	**79.15**	**56.7**		**97.9**		**78.8**
10	71.46	87.84	79.65	61.0	1836	101.5	1881	79.2
11	70.35	86.99	78.67	58.0	1854. 1873	100.0	1841	79.4
12	70.64	87.50	79.07	58.0	1863	100.0	"	79.4
13	69.99	88.61	79.30	57.0	1861	100.5	1862	79.6
14	70.69	88.66	79.67	56.5	1882	100.5	1868	79.6
	70.62	**87.92**	**79.27**	**58.1**		**100.5**		**79.4**
15	71.44	89.38	80.41	58.0	1842	100.0	1856	80.0
16	71.42	89.02	80.22	55.0	1863	100.0	1870	80.0
17	70.66	90.07	80.36	56.0	"	102.5	1856	80.0
18	70.77	88.73	79.75	58.0	1846	101.5	1868	79.6
19	70.44	87.70	79.07	58.0	1878	100.0	1854	79.4
	70.94	**88.98**	**79.96**	**57.0**		**100.8**		**79.8**
20	69.94	86.92	78.43	57.0	1873	100.5	1854, 1860	79.2
21	69.08	86.42	77.13	57.0	1869	104.0	1860	79.0
22	68.63	85.63	77.94	57.0	1864	101.5	1870	79.0
23	68.72	87.16	78.01	55.0	1861	98.5	"	79.0
24	69.01	87.86	78.43	56.0	"	101.0	"	78.8
	69.07	**86.79**	**77.93**	**56.4**		**101.1**		**79.0**

1836-1882	Mean Values for each Day.			Extreme Maxima and Minima observed on each Day of the Year.				Supposed true Mean
	Min.	Max.	Mean.	Min.	Year.	Max.	Year.	Mean
Jul. 25	70.24	88.38	79.31	59.0	1876	100.0	1870	78.6
26	70.73	88.27	79.50	58.0	1853	99.5	"	78.4
27	70.38	87.58	78.98	56.0	"	101.5	"	78 2
28	70.23	87.80	79.01	56.0	"	100.0	1838	78.0
29	70.58	87.58	79.08	61.0	1853, 1865	101.0	1854	78.0
	70.43	**87.92**	**79.17**	**58.0**		**100.4**		**78.2**
30	68.52	85.57	77.04	55.0	1847	101.0	1838	77.8
31	67.96	86.47	77.21	55 0	1849	100.0	1854	77.8
Aug. 1	68.38	87.33	77.85	52.0	1842	101.0	"	77.5
2	68.25	86.95	77.60	52.0	"	99.0	1861	77.5
3	68.61	86.59	77.60	55.0	"	101.0	"	77.5
	68.34	**86.58**	**77.46**	**53.8**		**100.4**		**77.6**
4	68.40	85.51	76.95	54.0	1880	101.5	1861	77.5
5	68.50	86.01	77.25	58.0	"	97.5	1858	77.5
6	68.97	87.18	78.07	58.0	1842	98.5	1838	77.5
7	69.11	87.07	78.09	57.5	1852	100.0	1861	77.4
8	68.96	87.09	78.02	56.0	1869	99.0	1850	77.4
	68.79	**86.57**	**77.68**	**56.7**		**99.3**		**77.4**
9	68.94	85 14	77.04	58.0	1879	104.0	1881	77.4
10	69.07	83.39	76.23	55.5	1882	98.0	"	77.4
11	69.37	86.44	77.90	57.0	"	100.5	"	77.4
12	68.38	86.47	77.42	56.0	1868	105.0	"	77.2
13	68 72	86.08	77.40	57.0	1860	101.5	1850	77.0
	68.89	**85.50**	**77.19**	**56.7**		**101.8**		**77.3**
14	68.49	85.30	76.89	56.5	1861	98.5	1857	77.0
15	68.52	85.39	76.95	59.5	"	97.0	1841	76.9
16	67.48	86.22	76 89	57.0	1866	96.0	1860	76.8
17	67.94	85.54	76.74	54.0	1855	97.0	1843, 1860	76.7
18	68.03	86.27	77.15	56.0	1855, 1866	99.5	1850	76.5
	68.09	**85.74**	**76.91**	**56.6**		**97.6**		**76.8**
19	68.19	85.25	76.72	56.0	1855	99.5	1850	76.4
20	66.88	85.72	76.30	52.0	1836	99.0	"	76.3
21	67.87	85.71	76.79	59.0	1864	97.0	1869	76.2
22	67.29	84.67	75.98	51.0	1837	97.5	1872	76.0
23	66.31	84.09	75.20	52.0	1866	97.5	1869	76.0
	67.31	**85.09**	**76.20**	**54.0**		**98.1**		**76.2**
24	66.63	85.29	75.96	49.0	1866	97.0	1872	75.8
25	66.38	84.42	75.40	50.5	"	100.0	"	75.5
26	67.02	84.94	75.98	49.0	1863	98.5	"	75.3
27	65.88	84.11	74.99	54.0	1856	97.5	1838	75.0
28	65.37	82.98	74.17	51.0	1844	97.5	1881	74.8
	66.25	**84.35**	**75.30**	**50.7**		**98.1**		**75.3**
29	64.80	83.05	73.92	49.0	1863	99.5	1881	74.5
30	64.55	84.34	74.44	45.0	"	100.5	1854	74.3
31	65.45	82.96	74.20	48.5	"	99.0	1854, 1873	74.2
Sept. 1	64.75	83.69	74.22	50.0	1849	98.5	1854	74.0
2	65.08	82.80	73.94	51.5	1850	102.0	1864	74.0
	64.93	**83.37**	**74.15**	**48.8**		**99.9**		**74.2**
3	64.54	83.00	73.77	51.0	1863	102.0	1864	74.0
4	65.10	83.59	74.34	51.0	1868	100.0	1881	74.0
5	65.33	82.15	73.74	50.0	1859	100.0	"	73.8
6	64.98	81.84	73.41	51.5	1848	97.0	"	73.6
7	65.61	83.17	74.39	52.0	1849	97.0	"	73.4
	65.11	**82.75**	**73.93**	**51.1**		**99.2**		**73.7**

1836-1882	Mean Values for each Day. Min.	Max.	Mean.	Extreme Maxima and Minima observed on each Day of the Year. Min.	Year.	Max.	Year.	Supposed true Mean
Sept. 8	64.48	83.47	73.97	49.5	1849	99.5	1854	73.0
9	63.79	80.63	72.21	50.0	1847, 1869	93.5	1841	72.0
10	62.59	79.95	71.27	46.5	1880	96.5	1842	71.0
11	61.01	78.90	69.95	47.5	1878	94.0	"	70.2
12	60.69	77.79	69.24	46.0	1839, 1878	92.0	1865	70.0
	62.51	**80.15**	**71.33**	**47.9**		**95.1**		**71.2**
13	60.27	77.85	69.06	47.0	1839, 1878	93.0	1851, 1864	70.0
14	60.37	79.16	69.76	43.5	1873	93.0	1846	69.5
15	60.51	77.88	69.19	47.5	1880	88.0	1849, 1862	69.0
16	60.76	79.34	70.05	47.0	1842	91.5	1857	69.0
17	60.54	77.72	69.13	40.5	1868	93.0	1843, 1857	68.5
	60.49	**78.39**	**69.44**	**45.1**		**91.7**		**69.2**
18	60.08	78.29	69.18	42.0	1863	92.5	1867	68.0
19	57.74	75.91	66.82	44.5	"	92.0	"	67.0
20	55.76	73.68	64.72	39.0	1875	93.5	1881	66.0
21	55.50	73.29	64.39	39.5	1866	95.0	1872	66.0
22	55.39	73.69	64.54	39.0	1875	92.0	1881	65.8
	56.89	**74.96**	**65.93**	**40.8**		**93.0**		**66.5**
23	58.17	76.82	67.49	36.0	1856	92.0	1881	65.5
24	58.15	76.23	67.19	37.0	"	92.5	"	65.0
25	57.09	75.37	66.23	42.0	1879	91.5	1850	64.8
26	54.61	73.81	64.21	40.0	1875	92.0	1847	64.5
27	54.87	73.82	64.34	41.5	1871	88.0	1854	64.3
	56.58	**75.21**	**65.89**	**39.3**		**91.2**		**64.8**
28	54.37	73.53	63.95	36.0	1839	90.5	1867	64.0
29	54.17	71.87	63.02	35.5	1846	93.0	1858	63.5
30	52.59	71.53	62.06	35.0	1851	90.0	"	63.0
Oct. 1	54.64	73.37	64.00	36.5	1856	87.0	1856	63.0
2	54.68	73.74	64.21	38.5	"	91.0	1867	63.0
	54.09	**72.81**	**63.45**	**36.3**		**90.3**		**63.1**
3	54.52	73.55	64.03	33.0	1840	89.0	1872	62.5
4	52.29	70.59	61.44	31.0	1836	88.5	"	62.0
5	52.18	70.36	61.27	34.0	"	88.0	1879	61.5
6	52.52	70.03	61.27	34.0	1855	88.5	1852	61.5
7	51.93	70.62	61.27	34.0	1873	87.0	1860	61.0
	52.69	**71.03**	**61.86**	**33.2**		**88.2**		**61.7**
8	51.70	71.14	61.42	31.5	1868	85.0	1856	60.5
9	51.49	70.66	61.07	36.5	1842, 1864	87.0	1879	60.0
10	51.26	69.91	60.58	37.0	1849	86.0	"	59.5
11	49.98	67.14	58.56	31.5	1872	86.0	"	59.0
12	48.73	64.91	56.82	30.0	1875	87.0	"	58.5
	50.63	**68.75**	**59.69**	**33.1**		**86.2**		**59.5**
13	45.99	65.96	55.97	29.5	1860	81.5	1879	58.0
14	47.20	65.24	56.22	29.5	1872	84.0	1878	57.5
15	46.88	65.82	56.35	28.0	1845	84.5	1881	57.0
16	47.34	65.64	56.49	27.0	1838	83.0	1842	56.0
17	46.80	65.42	56.11	31.0	1836, 1868	83.0	1839, 1842	55.0
	46.84	**65.61**	**56.23**	**29.0**		**83.2**		**56.7**
18	44.64	60.55	52.59	34.5	1875	82.5	1867	54.5
19	42.70	61.62	52.16	30.0	1846	84.0	1837	54.0
20	42.75	62.31	52.53	24.0	1836	83.0	1843	53.5
21	44.60	62.47	53.53	25.0	"	84.0	1837	53.0
22	44.15	61.47	52.81	30.0	1869	85.0	"	52.5
	43.77	**61.68**	**52.72**	**28.7**		**83.7**		**53.5**

1836-1882	Mean Values for each Day.			Extreme Maxima and Minima observed on each Day of the Year.				Supposed true Mean
	Min.	Max.	Mean.	Min.	Year.	Max.	Year.	
Oct. 23	43.41	61.54	52.47	20.0	1863	79.5	1839	52.0
24	44.32	60.64	52.48	20.0	"	78.0	1875	51.8
25	42.51	59.96	51.23	22.0	1841	78.5	1882	51.6
26	43.64	60.56	52.10	21.5	1862	81.5	1874	51.4
27	42.15	61.11	51.63	26.0	1869	81.5	1870	51.0
	43.20	**60.76**	**51.98**	**21.9**		**79.8**		**51.5**
28	43.54	60.56	52.05	27.0	1873, 1878	80.5	1874	51.0
29	43.71	60.77	52.24	22.0	1873	81.5	1875	50.5
30	42.34	57.28	49.81	26.5	1863	81.5	1876	50.5
31	39.75	56.66	48.20	19.5	"	80.0	"	50.0
Nov. 1	42.01	59.97	50.99	22.0	1873	78.0	1842, 1876	50.0
	42.27	**59.05**	**50.66**	**23.4**		**80.5**		**50.4**
2	43.20	58.00	50.60	30.5	1848	77.0	1847	50.0
3	41.11	56.59	48.85	25.5	1879	75.5	1859	49.8
4	42.01	58.66	50.33	23.0	"	80.0	1850	49.4
5	41.23	55.70	48.46	25.0	1865	72.5	1874	49.0
6	38.91	55.29	47.10	23.5	1877	73.0	1874, 1878	48.5
	41.29	**56.85**	**49.07**	**25.5**		**75.6**		**49.3**
7	40.78	57.55	49.16	24.0	1856	77.0	1874	48.0
8	40.30	55.78	48.04	11.0	1838	75.5	1868	47.0
9	37.43	51.88	44.66	16.0	"	75.0	1844	46.0
10	39.03	52.71	45.87	20.0	"	76.0	"	45.5
11	40.23	53.53	46.88	26.5	1869	81.5	1837	45.0
	39.55	**54.29**	**46.92**	**19.5**		**77.0**		**46.3**
12	36.93	51.66	44.29	17.0	1859	71.5	1879	44.5
13	36.66	52.82	44.74	15.0	"	79.0	"	44.0
14	36.67	51.86	44.26	20.0	1872	71.5	1855	43 5
15	35.18	50.01	42.59	18.0	1838	72.0	1873	43.0
16	36.11	49.60	42.85	10.0	"	69.0	1865	42.0
	36.31	**51.19**	**43.75**	**16.0**		**72.6**		**43.4**
17	35.55	47.80	41.67	12.0	1838	69.0	1853	41.0
18	33.62	45.58	39.60	6.0	1880	72.0	"	40.5
19	31.60	45.03	38.31	7.5	"	71.0	"	40.0
20	32.59	45.11	38.85	9.5	1872	72.5	1837	39.5
21	33.09	45.84	39.46	10.5	1880	69.0	1841	39.0
	33.29	**45.87**	**39.58**	**9.1**		**70.7**		**40.0**
22	32.28	45.92	39.10	6.5	1880	71.0	1843	38.5
23	32.14	43.97	38.05	9.5	1871	69.0	1867	38.0
24	29.85	41.93	35.89	5.5	1860	65.5	1850	37.8
25	29.83	41.92	35.87	0.0	1839	64.5	1856	37.6
26	31.25	44.06	37.65	14.0	"	65.0	1850	37.4
	31.07	**43.56**	**37.31**	**7.1**		**67.0**		**37.6**
27	31.44	43.22	37.33	5.0	1845	67.0	1870	37.0
28	31.64	44.05	37.84	— 0.5	"	72.0	1864	36.8
29	29.04	42.76	35.90	2.0	1872	76.5	"	36.4
30	28.55	42.98	35.76	6.5	1845	72.5	1837	36.0
Dec. 1	30.33	45.57	37.95	— 1.0	"	72.5	"	36.0
	30.20	**43.71**	**36.95**	**2.4**		**72.1**		**36.4**
2	31.06	44.95	38.00	4.0	1876	72.0	1864	35.8
3	30.61	43.00	36.80	8.0	1859	61.0	1842, 1873	35.6
4	30.75	42.18	36.46	— 2.5	1871	59.0	1877	35.4
5	29.45	41.33	35.39	2.5	"	61.0	1879	35.2
6	29.56	41.88	35.72	3.5	1859	62.0	1861	35.0
	30.28	**42.67**	**36.47**	**3.1**		**63.0**		**35.4**

1836-1882	Mean Values for each Day.			Extreme Maxima and Minima observed on each Day of the Year.				Supposed true Mean
	Min.	Max.	Mean.	Min.	Year.	Max.	Year.	
Dec. 7	28.00	40.23	34.11	—11.0	1882	63.0	1851	34.0
8	27.79	39.11	33.49	— 4.0	"	65.0	1861	33.5
9	25.07	35.35	30.21	— 5.0	1876	74.5	"	33.0
10	23.89	36.06	29.97	0.0	1868	68.0	"	32.5
11	28.19	37.61	32.90	—11.0	"	68.0	1873	32.0
	26.59	**37.67**	**32.13**	**— 6.2**		**67.7**		**33.0**
12	25.54	37.15	31.34	— 0.5	1868	68.5	1877	31.8
13	26.25	36.70	31.47	4.0	1865	62.5	1881	31.6
14	23.46	33.79	28.62	— 1.0	"	59.0	1861	31.4
15	23.57	33.46	28.51	— 2.5	1851	67.5	1877	31.2
16	24.29	34.83	29.56	— 0.5	"	62.0	"	31.0
	24.62	**35.18**	**29.90**	**— 0.1**		**63.9**		**31.4**
17	25.10	36.91	31.00	— 2.5	1875	67.0	1877	31.0
18	25.76	38.87	32.31	1.0	1876	69.0	"	30.8
19	26.37	38.10	32.23	0.5	1863	67.5	"	30.6
20	23.51	35.84	29.67	— 2.0	1871	65.0	"	30.4
21	24.84	36.97	30.90	— 2.0	1865	66.0	"	30.0
	25.11	**37.34**	**31.22**	**— 1.0**		**66.9**		**30.5**
22	22.64	33.86	28.25	—14.0	1872	62.0	1877	30.0
23	22.51	35.34	28.92	— 7.0	1870	61.0	1875	30.2
24	23.90	36.62	30.26	—19.5	1872	66.0	"	30.5
25	25.42	37.95	31.68	—11.0	"	70.0	1867	31.0
26	25.63	38.06	31.84	— 5.0	"	65.0	1875	31.2
	24.02	**36.36**	**30.19**	**—11.3**		**64.8**		**30.6**
27	26.47	38.41	32.44	— 6.0	1872	65.0	1846	31.3
28	26.34	37.80	32.07	— 6.0	1880	59.0	1862	31.5
29	25.83	37.49	31.66	—18.0	"	64.0	1851	31.5
30	23.26	36.73	29.99	— 8.0	"	66.0	1875	31.5
31	24.25	38.43	31.34	—10.5	1863	73.5	"	31.5
	25.23	**37.77**	**31.50**	**— 9.7**		**65.5**		**31.5**

The annexed diagram, for the construction of which I am indebted to Dr. G. Hambach, represents the principal results of these tables. The perpendicular lines divide the year into 73 periods of 5 days each, while the horizontal ones mark the degrees. The central full-faced curve indicates the Mean Temperature of the penthemeral periods of the 47 years, as actually found, while the dotted line represents the supposed real Mean Temperature as suggested in the last column of these tables. The uppermost curve shows the Highest Temperatures and the lowest curve the Lowest Temperatures observed in those same penthemeral periods within the same number of years. It will be noticed that while the points of Mean Temperature occupy the centre of each period, the Maxima and Minima do not show in the middle of the spaces, but on that one of the 5 days of the period on which they actually did occur.

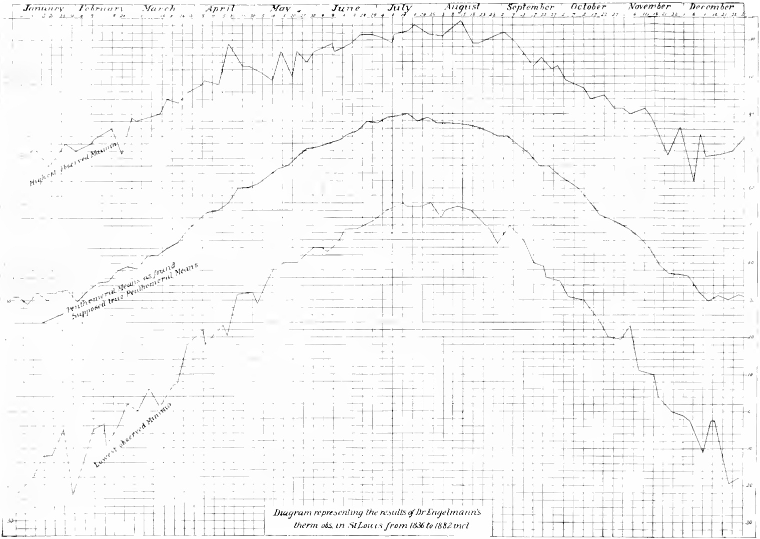


Diagram representing the results of Dr Engelmann's therm obs. in St Louis from 1836 to 1882 incl

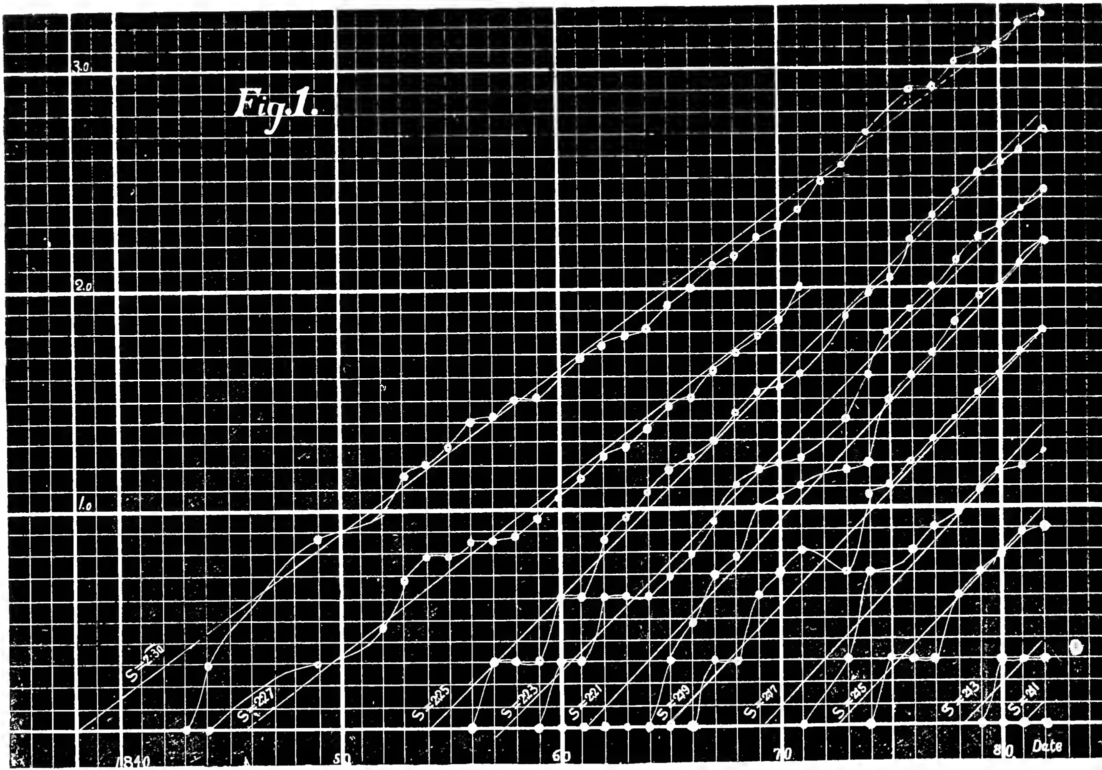

3.0
2.0
1.0
S=2.30
S=2.27
S=2.25
S=2.23
S=2.21
S=2.19
S=2.17
S=2.15
S=2.13
S=2.11
1840
50
60
70
80
Date

Fig. 1.

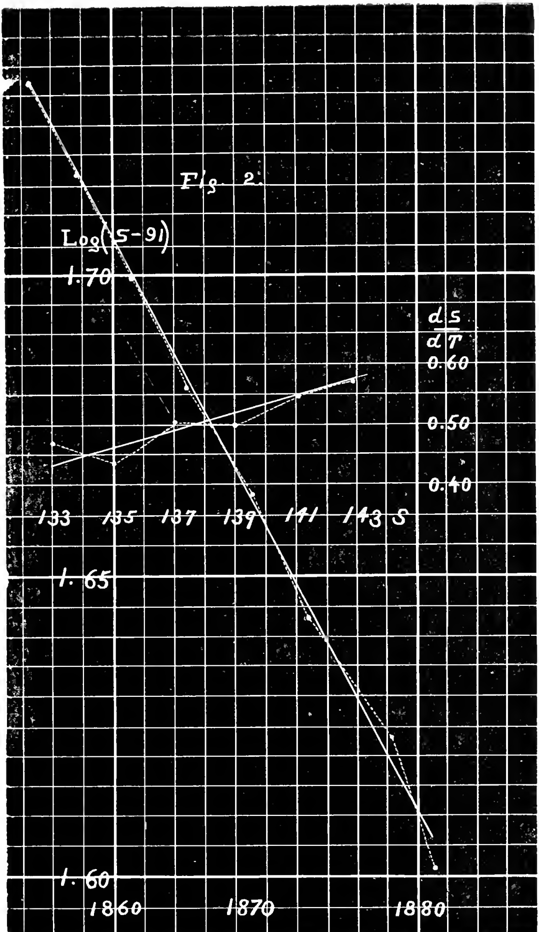


Fig. 2.
Log (S-91)
1.70
1.65
1.60
ds/dT
0.60
0.50
0.40
133
135
137
139
141
143 S
1860
1870
1880

*The Evolution of the American Trotting-Horse.**

By Francis E. Nipher.

In the American Journal of Science for April, 1883, Prof. W. H. Brewer has furnished data for the discussion of the change in speed of the American trotting-horse. His table is here reproduced.

TABLE SHOWING THE NUMBER OF HORSES UNDER THE RESPECTIVE RECORDS.

Year.	2:30 or better	2:27 or better	2:25 or better	2:23 or better	2:21 or better	2:19 or better	2:17 or better	2:15 or better	2:13 or better	2:11 or better
1843	1	......	......	......	......	......	......	......	......	......
1844	2	1	......	......	......	......	......	......	......	......
1849	7	2	......	......	......	......	......	......	......	......
1852	10	3	......	......	......	......	......	......	......	......
1853	14	5	......	......	......	......	......	......	......	......
1854	16	6	......	......	......	......	......	......	......	......
1855	19	6	......	......	......	......	......	......	......	......
1856	24	7	1	......	......	......	......	......	......	......
1857	26	7	2	......	......	......	......	......	......	......
1858	30	7	2	......	......	......	......	......	......	......
1859	32	9	2	1	1	......	......	......	......	......
1860	40	11	4	2	1	......	......	......	......	......
1861	48	14	4	2	1	......	......	......	......	......
1862	54	17	7	4	1	......	......	......	......	......
1863	59	19	9	4	1	......	......	......	......	......
1864	66	22	12	4	1	......	......	......	......	......
1865	84	29	15	5	2	1	......	......	......	......
1866	101	32	17	6	3	1	......	......	......	......
1867	124	42	21	9	5	2	......	......	......	......
1868	146	52	28	13	6	2	......	......	......	......
1869	171	63	34	15	10	4	......	......	......	......
1870	194	72	35	16	11	5	......	......	......	......
1871	233	99	40	17	12	6	1	......	......	......
1872	323	......	......	......	......	......	......	......	......	......
1873	376	......	74	28	15	5	2	......	......	......
1874	506	......	98	40	16	11	5	1	......	......
1875	......	......	134	61	30	13	5	2	......	......
1876	794	......	165	81	39	16	6	2	......	......
1877	836	......	214	105	51	19	8	2	......	......
1878	1025	......	270	129	68	24	9	4	......	......
1879	1142	......	325	164	88	33	11	5	1	......
1880	1210	......	366	192	106	41	14	6	2	1
1881	1532	......	419	227	126	49	15	7	2	1
1882	1684	......	495	275	156	60	18	8	2	1

Prof. Brewer states that the data for the speeds 2:30 and 2:27 are very unsatisfactory, but for all the others are reasonably correct.

On taking the logarithms of all the numbers N of horses capable of trotting a mile in s seconds, it results that the plotted values of log. N for their proper dates give a straight line for each value of s. For the speeds s of 2:30 and 2:27 these lines are parallel to each other, and the lines representing the remaining

* Read May 7th, 1883.

speeds are also parallel to each other, but the two groups are not parallel.

For the first set, the lines can be represented by the equation

$$\log N = A' + 0.075\, T,$$

where A' is a function of s, and T is estimated in years from any arbitrarily assumed date.

For the second group,

$$\log N = A' + 0.10\, T.$$

It is apparent that for the speed of 2:30 and 2:27 the values of N are too small, for the reason perhaps that in earlier years, when this was called good time, less general attention was paid to the breeding of trotters, while in later years, as this became a common speed, a constantly increasing number of horses of this grade have been used as roadsters and remained undiscovered in private hands.

These plotted lines are shown in Fig. 1. It is clear that the intersection of any one of these lines with the time axis determines the date when this speed may be supposed to have originated, or when $N = 1$, and that this determination of the date, based as it is upon a number of observations running through a series of years, is much more reliable than the date when some accidentally arranged trotting match revealed the fact that the horse capable of making this speed had already come.

The dates for the origin of the speeds of 2:13 and 2:11 cannot yet be determined very accurately, and this fact is to be remembered in considering the discussion which follows.

The following table gives the values of s in seconds and the dates for the origin of these speeds, determined as before explained. The third column contains the change in speed per year, calculated in a well known manner from alternate differences in the two previous columns.

s.	YEAR.	$\frac{ds}{dT}$
145	1854.0	.....
143	1857.4	0.571
141	1861.0	0.547
139	1864.7	0.500
137	1869.0	0.506
135	1872.6	0.430
133	1878.3	0.476
131	1881.0	.....

When the values of $\frac{ds}{dT}$ are plotted with the simultaneous values of s, we get a somewhat irregular series of points shown in Fig 2, and represented fairly well by the equation

$$\frac{ds}{dT} = A + Bs \qquad - \quad - \quad - \qquad (1)$$

The constants A and B can be determined graphically with as great precision as the nature of the data will warrant.

The values are found to be

$$A = -1.00$$
$$B = +0.0110,$$

and the differential equation (1) becomes

$$\frac{ds}{dT} = -1.00 + 0.0110\, s \qquad - \quad - \qquad (2)$$

This equation being put into the form

$$\frac{ds}{s - 90.9} = 0.0110\, dT,$$

it admits of direct integration as follows,

$$\int_{s_0}^{s} \frac{ds}{s-90.9} = 0.0110 \int_{T}^{T_0} dT$$

on performing the indicated operations

$$l\,(s-90.9) = l\,(s_0 - 90.9) + 0.0110\, T_0 - 0.0110\, T,$$

where s_0 and T_0 are simultaneous values at any assumed date.

Placing the initial values in a single term, we have

$$l\,(s-90.9) = C - BT \qquad - \quad - \qquad (3)$$

or for the primitive equation

$$s = 90.9 + e^{C-BT} \qquad - \quad - \qquad (4)$$

where e is the Naperian base.

It thus appears that the limiting speed of which the trotting-horse is capable, which he will continually approximate and never reach, is 1:31. This follows from (2) by making $\frac{ds}{dT} = 0$, or from (3) and (4) by making $T = \infty$.

The constants B and C are best determined by taking the logarithms of $(s-91)$ for the various values of s, and plotting them on the time axis. These values are given in the following table:

s.	$s-91$.	log $(s-91)$	YEAR.	T.	s calc.	DIFF.
145	54	1.732	1854.0	− 6.0	144.8	−0.2
143	52	1.716	1857.4	− 2.6	142.9	−0.1
141	50	1.699	1861.0	+ 1.0	140.9	−0.1
139	48	1.681	1864.7	+ 4.7	139.2	+0.2
137	†6	1.663	1869.0	+ 9.0	137.2	+0.2
135	44	1.643	1872.6	+12.6	135.2	+0.2
133	42	1.623	1878.3	+18.3	132.6	−0.4
131	40	1.602	1881.0	+21.0	131.4	+0.4

The constants are determined by well known graphical methods, and it is thus found that the observations are represented by the equation

$$\log (s-91) = 1.703 - 0.00 \quad T, \qquad (5)$$

where the logarithms are common, and T is estimated in years from 1860. Substituting in (4) the values of T for the dates of the above table, the values of s and their differences from the observed values of s have been determined and are given in the final column. These differences are seen to be greatest for the later dates, where the possible errors are known to be greatest; but the error in s even here corresponds to an error of only a year in date, which is certainly within the error of observation.

From (5) it is easy to determine the date when the horse will have reached within one second of the limiting speed. Making $s = 92$, this value of T turns out to be 370 years. By the close of the present century the time of trotting a mile will be reduced to 2:04, and the time of 2:00 will be reached in the year 1912. But they indicate that the trotting-horse will finally be able to make his mile in a time not differing materially from the time of the running-horse, which is at present about 100 seconds. Whether or not the trotting-horse will finally beat the running-horse, as the present results seem to indicate, it is perhaps not possible to decide at present with the insufficient data at our command. A weighty consideration is found in the fact that a well trained trotter carries his body more steadily, or with less of rise and fall, than the racer, and this may possibly result to the final advantage of the trotting-horse after the process of developing and adjusting of his muscles and chest shall have been sufficiently carried on, so that the contest between the trotter and the racer shall have been reduced to a matter of muscular capacity.

It is well known that some herds of wild horses on the Texas plains were natural pacers, and even when pushed to the utmost, and for days together, by the best running-horses, the greater portion of them held to their gait. One large white pacer became widely known and his capture was often attempted, but he always proved more than a match for the best horses that could be brought against him.

Whatever may be said about the particular numerical results of this discussion, it is clear that the trotting-horse is very likely to reach a much higher speed than has been heretofore thought possible.

Added Nov. 7, 1883.

In the November number of the American Journal of Science Mr. W. H. Pickering has criticised the method of reduction used in the present paper (which had been printed from advance sheets in the July number of that journal), and has reached a very different conclusion from that reached in the present paper.

Mr. Pickering thinks that it is objectionable to determine the value of $\frac{ds}{dT}$ by taking the alternate differences in s and T, and he has reduced the observations by taking differences between consecutive values in the table. In this way he gets the values of the third column in the table below.

s.	YEAR.	$\frac{ds}{dT}$	$\frac{ds}{dT}$ calc.	e.
145	1854.0	0.59	0.59	0.0
143	1857.4	0.55	0.56	− 0.1
141	1861.0	0.54	0.54	0.0
139	1864.7	0.46	0.51	− 0.4
137	1869.0	0.55	0.49	+ 0.4
135	1872.6	0.35	0.46	− 1.4
133	1878.3	0.75	0.44	+ 1.8
131	1881.0			

Plotting these values of $\frac{ds}{dT}$ and the corresponding values of s, he then goes on to say that the points so determined may be represented by a curve, such that the value of $\frac{ds}{dT}$ increases as s

diminishes, and thus indicating disturbing causes not easily discussed. Assuming that a straight line will represent the values, he determines the value of the constants, and finds that the line intersects the axis of s at a point where the value of s is — 25. This would mean that the limiting speed of the trotter is 25 seconds less than no time at all.

When making his first discussion of the subject, the writer considered the propriety of determining the value of $\frac{ds}{dT}$ by means of consecutive differences, and unfortunately rejected the method without even giving it a trial, for the reason that the dates $1881._0$ and $1878._3$, corresponding to the values 131 and 133 of s, were very imperfectly determined. It was clear that the additional point thus secured would deserve very little weight. It was thought to diminish the irregularity of the line by combining these with previous and better determined dates. Mr. Pickering has not only used this method (which properly used is capable of yielding good results), but he has given equal weights to the values of $\frac{ds}{dT}$ for all the dates in the table. This is the fatal defect which entirely vitiates the conclusion reached by him. A reference to Fig. 1 of this paper will show that for the earlier dates from $1854._0$ down to $1872._6$ the graphically determined dates differ from the real dates when the record was actually lowered by from one to two years.

It will also be seen that the dates $1878._3$ and $1881._0$ are subject to errors which may be as great as two years. After having made a preliminary examination, these dates might indeed have been "adjusted" so as to make them agree better with the others, but they now stand exactly as they did when first made and before any other work had been done. It is clear that the most weight should be given to the earlier dates. I have therefore plotted the new values of $\frac{ds}{dT}$ with the values of s, and have drawn the line representing the values so as to give most weight to the best determined values. The equation of this line is

$$\frac{ds}{dT} = -1._{24} + 0._{0127}\, s. \qquad - \quad - \quad - \qquad (6)$$

From this equation the values of $\frac{ds}{dT}$ were calculated as given in the fourth column of the last table. The fifth column, headed e, gives the time in years by which the corresponding time intervals dT must be increased in order to bring Mr. Pickering's values of $\frac{ds}{dT}$ into accordance with the values calculated from the above equation. In this case the intervals are supposed to be separately adjusted. If the later dates were simultaneously adjusted or changed by intervals ranging from two-tenths to three-fourths of a year, the values of $\frac{ds}{dT}$, which Mr. Pickering prefers to use, would agree exactly with the values calculated from the last equation. Now it is perfectly clear that these later dates, and particularly the last two, are subject to just such errors as this.

Whatever these values of $\frac{ds}{dT}$ may be said to prove, they certainly do not prove that my results as before published are absurd, and they do not indicate a limiting speed of -25 seconds. If $\frac{ds}{dT} = 0$, the limiting speed of the horse is found to be 98 seconds.

I desire to express my thanks to Mr. Pickering for his criticisms and suggestions, as he has corrected a tendency which I had begun to feel, to attach too much importance to the numeri cal result reached; but I maintain that his method, correctly applied, gives in general, substantially, the same result as my own. It is not necessary to assert that this result is really correct if any person feels inclined to doubt it, because at present it is not possible to demonstrate it more fully than has been done in the present paper. I only insist that it is not wholly unwarranted by the facts which we now know.

Most horsemen seem to think that the limiting speed of the trotting-horse will be somewhere near a mile in 120 seconds. If this were true, the differential equation could hardly be a linear one. The equation

$$\frac{ds}{dT} = k\sqrt{s - L} \qquad (7)$$

where k is a constant and L is the limiting speed, would however be in harmony with this view. But this equation gives on integration an equation of the form

$$\sqrt{s - L} = C - AT \qquad (8)$$

According to this equation the horse would absolutely reach the limiting speed L in a finite time, $\frac{C}{A}$. Practically this may be true, as is in fact shown by my own equation (4), so that some such equation might really represent the results sufficiently near for all practical purposes. But the relation is not a rational one, since it cannot be supposed that the horse will really attain his limiting speed in a finite time. After he had come within a thousandth of a second, it would take a great interval of time to compass the next millionth of a second. Furthermore, this equation could not hold for values of T greater than $\frac{C}{A}$, as the value of s would then begin to increase according to equation (8). I therefore claim that equation (4), in all probability, represents the relation between the values of s and T, and that the constants in the equation will be determined with greater and greater precision as the data becomes more and more complete.

Magnetic Survey of Missouri. Fifth Annual Report.

By Francis E. Nipher.

During the summer of 1882 the survey was continued under the same auspices as in the previous year. The friend who furnished the entire means for conducting the work enlarged upon his former bounty, and furnished the party with two fine spring-wagons designed with reference to the needs of camp life, and provided with all needed conveniences. Two paid assistants, Messrs. Joseph Cunningham and Albert Meyer, were also sent with the expedition, and Mr. Frank Ringling of the Sophomore class accompanied the expedition as volunteer assistant, paying his own expenses.

The work of the summer was interfered with in a serious manner by the sickness of the horses, and more particularly by the horrible condition of the roads, due to heavy and long-continued rains. During the entire summer we were compelled to improve roads and fords, and to build bridges, and this frequently took up a quarter of our time during an entire week. This made it impossible to make complete observations after Aug. 7th, as we were obliged to travel every day in order to reach St. Louis within the time which could be devoted to the survey. After the above date, therefore, only declination observations were made, the magnetic meridian being determined from the morning elongation as explained in the previous report.* The true meridian was in nearly all cases obtained by pole-star observations, but the great number of cloudy nights made it necessary in some cases to observe at other times than at elongation.

A description of the stations where observations were made is here given, the numbers being continued from the previous report.

STATION 101 — *Kirkwood, St. Louis Co.* Lat. 38° 36′; lon. 90° 24′. In the orchard of H. W. Leffingwell, 128 feet from the street fence on the south, and 150 feet from that on the east. Polaris observation on elongation.

STATION 102 — *Gray's Summit, Franklin Co.* Lat. 38° 29′; lon. 40° 49′. On the Union road about half a mile to the S.W. from the railroad crossing, and in the second depression, 20 ft. from the road, and on the N.W. side. Polaris obs. on elongation.

STATION 103—*Newport, Franklin Co.* Lat. 38° 36′; lon. 91° 06′. In the "old town" on the summit of a small ridge, 128 ft. N.W. from the N.W. corner of the church. A large elm to the N.W. across the small water-course is said to be at, or very near, the N.W. corner of the S.E. qr. of sec. 11, tp. 44, r. 2 W. Polaris obs. on elongation.

STATION 104—On the farm of August Goebel, near *Newport.* Lat. 38° 34′; lon. 91° 06′. The station was within a few feet of the middle point of the line dividing the E. half of the S.W. qr. from the W. half of the S.E. qr. of sec. 15, tp. 44, r. 2 W. Polaris obs. on elongation. In this immediate vicinity Dr. Goebel, grandfather of the present owner of the farm, had established two magnetic stations, where he made extended and careful observations. The original records of this work were given to the U. S. Coast Survey some years since by his son, Mr. Gert Goebel.

The earlier station of Goebel is found by going from our station in a line bearing S. 93° 34′.5, E. 255 ft. and thence N. 83 ft. This station of Goebel's is 61 ft. W. and 14 ft. N. of the S.W. corner of the house of August Goebel. The observations here were made in the year 1839. The declination was 9° 21′ E.

The other station of Dr. Goebel was occupied in the year 1849. It is at the S. window of a now abandoned stone house, the N.W. corner of which is 158 ft. W. and 193 ft. S. of our station. The house is a one-story structure, having the dimensions of N. and S. sides 18 ft., and E. and W. sides 24 ft. The window where his observations were made is in the middle of the S. side. His value for declination in 1849 was 9° 05′ E. Our value determined June 22d, 1882, was 7° 36′.

STATION 105—*In Franklin Co.* Lat. 38° 41′; lon. 91° 20′. The station is on timber land of Elijah Ruck, 315 ft. N. and 15 E. of the well in

* Trans. iv. 3, p. 454.

front of the house of John Bedts, and about 325 ft. from the line between Franklin and Gasconade counties. The station was said to be in sec. 10, tp. 45, r. 4 W. Polaris obs. on elongation.

STATION 106 — *In Gasconade Co.* Lat. 38° 37′; lon. 91° 29′. On the land belonging to Fred. Bruhns. a quarter of a mile N. and 260 ft. E. of the S.W. corner of sec. 19, tp. 45, r. 5 W. The station is on the bank of First creek. The value for declination here was very much smaller than at surrounding stations, but no error could be detected in our work. Whether the discrepancy was due to some minute local effect or not, we could not remain to determine, as sickness at home made it desirable to reach the telegraph as soon as possible. This is the only case of the kind so far reached, excepting in the Iron Mountain region. Two Polaris observations were made on elongation.

STATION 107 — *In Osage Co.* Lat. 38° 28′; lon. 91° 41′. On the land of Fritz Kaldeweiher, near the centre of the S.E. qr. of the S.W. qr. of sec. 9, tp. 43, r. 7 W. The station was 50 ft. N. and 33 ft. W. of the N.W. corner of Kaldeweiher's house. Polaris obs. on elongation.

STATION 108 — *Linn, Osage Co.* Lat. 38° 28′; lon. 91° 50′. Station on L'Ours creek* on the Jefferson city road, about half a mile from town. The S.E. corner of James N. Clark's yard is 72 ft. W. and 68 ft. S. of the station. Polaris obs. on elongation.

STATION 109—*In Callaway Co.* Lat. 38° 43′; lon. 92° 01′. On Little Auxvasse creek at the crossing of the New Bloomfield and Fulton road, about 40 rods S.W. of the N.E. corner of sec. 28, tp. 46, r. 10 W. A spring across the creek and just at the ford lies N. 65° E. 165 ft. Polaris obs. on elongation.

STATION 110—*Near Stephens' Store, Boone Co.* Lat. 38° 58′; lon. 92° 05′. About one half mile S. of the village. The old Fulton road is 12 ft. W. and the bank of Cedar creek is 105 ft. N. Polaris obs. on elongation.

STATION 111 — *Centralia, Boone Co.* Lat. 39° 13′; lon. 92° 05′. The station was on a vacant lot 48 ft. W. of the centre of the street leading directly S. to the depot and crossing of the Chicago & Alton R.R., which is about a square and a half distant. The centre of the street to the N. is distant 77 ft. and leads E. to a flouring mill, the smokestack of which bears S. 90° 44′.1 E. Polaris obs. on elongation.

STATION 112 — *In Monroe Co.* Lat. 39° 24′; lon. 92° 10′. On the S. bank of the Long Branch of Salt river. The station was 150 ft. from the creek and midway between the road and the W. fence. The station is on the W. line of sec. 20, tp. 53, r. 11 W., and about 120 yds. from the middle of this line. Polaris obs. on elongation. — Some years since the county surveyor of Audrain Co. called my attention to this region as showing

* Named after the first (French) settler on its banks. A postoffice near the stream was afterwards named "Loose Creek" P. O. by some poor speller, and this official name has since been applied to the stream, which appears on some maps as "Loose Creek."

marked local effects. The region is level prairie, and long N. and S. lines run by compass are greatly and uniformly curved, showing an abnormally great easterly declination. This station and station No. 144, about 12 miles E., show an area of abnormal easterly declination. The disturbed region extends over an area of many miles.

STATION 113—*Moberly, Randolph Co.* Lat. 39° 26′; lon. 92° 26′. On the fair grounds 184 ft. E. and 289 ft. S. of the W. entrance. Polaris obs. on elongation.

STATION 114—*Macon, Macon Co.* Lat. 39° 46′; lon. 92° 30′. In the stock-yard of O. S. Bearce, directly in front of his barn and 20 ft. from the Vine-st. fence. The city school-house is one square W. and one square N. Polaris obs. on elongation.

STATION 115—*In Macon Co.* Lat. 39° 48′; lon. 92° 37′. On the farm of Isaiah Lewis, which is the N. half of N.E. qr. of sec. 21, tp. 58, r. 15 W. The station was in front of the house, and midway between the road and the yard fence. Polaris obs. on elongation.

STATION 116—*Near Mercyville, Macon Co.* Lat. 39° 57′; lon. 92° 42′. About half a mile N. of town. A corner-stone in the road, a quarter of a mile S. of the middle point of the N. line of sec. 35, tp. 60, r. 16 W., bears S. 3° 23′ W. 589 ft. Polaris obs. on elongation.

STATION 117—*In Linn Co.* Lat. 39° 54′; lon. 93° 07′, In the bottom of the west branch of Yellow creek. The station is within a few feet of the corner, a quarter of a mile due E. of the middle point of the E. line of sec. 22, tp 59, r. 19 W. A large white-oak tree stands 20 ft. W., and the east end of the bridge is 261 ft. distant. The mark used was an iron rod on the bridge, 11 ft. west of the centre of the bridge. Polaris obs. on elongation.

STATION 118—*Linnæus, Linn Co.* Lat. 39° 51′; lon. 93° 13′. On a vacant lot on the summit of the hill E. of the Burlington & South-western R.R. depot. The S. line of the yard of Chas. B. Purdin lies 166 ft. N., the N. line of the farm of Joel Wilkinson lies 166 ft. S., while the field to the E. across the road is 237 ft. distant. The court-house spire was used as a mark. Two polaris observations on elongation.

STATION 119—*Near Laclede, Linn Co.* Lat. 39° 47′; lon. 93° 17′. Station one mile W. of town, on the E. side of Muddy creek; about 350 ft. E. of the bridge and 20 ft. N. of the road centre. The station is said to be on the S.E. qr. of sec. 36, tp. 58, r. 21 W. Polaris obs. on elongation.

STATION 120—*In Livingston Co.* Lat. 39° 38′; lon. 93° 45′. On the farm of Wm. E. Wolfort, in the N.E. qr. of the S.E. qr. of sec. 33, tp. 56, r. 25 W. The station was in the cattle-yard 25 ft. from the road fence to the east (the road being on the section line), and 40 ft. N. of the door-yard fence.. The middle line of the section is in the E. and W. road perhaps, 100 ft. N. Polaris obs. on elongation.

STATION 121—*Kingston, Caldwell Co.* Lat. 39° 41′; lon. 94° 04′. The station will be found by going from the S.W. corner of the court-house square W. 1646 ft., and S. from the middle of the road 62 ft. It lies 91 ft. E. of the summit of the small ridge. Polaris obs. on elongation.

STATION 122 — *In Caldwell Co.* Lat. 39° 39′; lon. 94° 11′. On land of Christian Smitt, 50 ft. W. and 212 ft. N. of the middle of sec. 29, tp. 56, r. 29 W. Polaris obs. on elongation.

STATION 123—*Maysville, DeKalb Co.* Lat. 39° 43′; lon. 94° 24′. On the grounds of the public school building, 65 ft. W. and 21 ft. N. of the N.W. corner of the building. Polaris obs. on elongation.

STATION 124 — *In DeKalb Co.* Lat. 40° 01′; lon. 94° 23′. On land of Harvey Johnson, 50 ft. S. and 206 ft. E. of the middle of the N. line of sec. 14, tp. 60, r. 31 W. Polaris obs. on elongation.

STATION 125 — *Albany, Gentry Co.* Lat. 40° 15′; lon. 94° 21′. The station is 979 ft. E. of the N.E. corner of the court-house square and 8 ft. S., these measurements being along the streets. The station is 11 ft. W. and 8 ft. S. of the N.E. corner of lot 2, block 5, of Hundley's second addition. Polaris obs. on elongation.

STATION 126 — *In Gentry Co.* Lat. 40° 16′; lon. 94° 17′. The fence E. on the E. edge of sec. 15, tp. 63, r. 30 W., is 107 ft. distant. The fence S , which is the S. line of the N. half of the N.E. qr. of the section, is 193 ft. distant. There appears to be a double corner here. The evening-mark reading was missed, but the station was on raw prairie and the instrument was certainly not disturbed between the star observation and the morning mark reading. Polaris was observed on elongation.

STATION 127—*Bethany, Harrison Co.* Lat. 40° 16′; lon. 94° 03′. On a vacant lot of Mrs. R. J. Turner, 365 ft. E. of the N.E. corner of her house. The station is about 320 ft. S. of the N. line and 346 ft. W. of the E. line of sec. 15, tp. 63, r. 28 W. The line fence of T, B. Shearer's yard is 101 ft. E. Polaris obs. on elongation.

STATION 128 — *Farm of John Honan, in Harrison Co.* Lat. 40° 08′; lon. 93° 56′. The station was in the meadow, 133 ft. S. and 289 ft. W. of the N.E. corner of sec. 36, tp. 62, r. 27 W. Meridian determined by equal altitudes of the sun. Small cumulus clouds cut off five observations out of a series of seven. The two differed 1′.

STATION 129—*In Daviess Co.* Lat. 40° 04′; lon. 93° 53′. The station was in the road ahout midway between the track and the S. fence, and 334 ft. E. of the N.W. corner of the S. half of the S.W. qr. of sec. 28, tp. 61, r. 26 W. By reason of a very heavy rain which came up while the camp was being made it was impossible to get an evening-mark reading. The rain lasted until 9:15 P.M., and then a small patch of sky cleared around polaris for about half an hour, and a pole-star observation was made.

When the star-observation was made the whole hillside was covered with a sheet of water three to four inches inches in depth, which filled the trenches around the tent and ran through the tent in a torrent. The ground was however firm, and the tripod was as usual mounted firmly on large stakes driven eight to ten inches into the ground. The observation was therefore deemed entirely satisfactory. At the next station on the next night an observation was made the same interval before elongation, and the difference between the azimuth of the star and that of elongation agreed within a quarter of a minute with that at Station 129.

STATION 130—*Trenton, Grundy Co.* Lat. 40° 03′; lon. 93° 39′. Station in a grove of Dr. Harris, in the east part of town. The station is found by starting at the front (S.) fence of the door-yard and measuring S. along the centre of the road 112 ft., thence E. 415 ft. Polaris obs. on elongation.

STATION 131—*In Grundy Co.* Lat. 40° 13′; lon. 93° 38′. Station in the road about midway between the track and the E. fence, and 150 ft. S.W. from the front gate of the farm of Faust Amick. The station is near the S.E. corner of the N.E. qr. of N.E. qr. of sec. 34, tp. 63, r. 24 W. Polaris was observed before elongation, and its azimuth calculated as before described.

STATION 132—*Princeton, Mercer Co.* Lat. 40° 24′; lon. 93° 39′. The station is at the base of the bluff, 395 ft. W. of the W. side of Lincoln st. and 563 ft. N. of the centre of Hickland st. Polaris observations were made at 9 and 12h. 30 m.

STATION 133—*In Putnam Co.* Lat. 40° 27′; lon. 93° 21′. On land of Joseph Williams, about a quarter of a mile W. of the centre of sec. 7, tp. 65, r. 21 W. The station was about 20 ft. N. of the centre of the road, and 250 ft. E. of the front gate of the house of Crede Yocum. Polaris obs. on elongation.

STATION 134—*In Putnam Co.* Lat. 40° 27′; lon. 93° 21′. Station in a lane near the house of Joseph Ward, in sec. 12, tp. 65, r. 20 W. The middle stone of the S. line of the section is 189 ft. S. of the station. Polaris observed at 11 o'clock P.M.

STATION 135—*Unionville, Putnam Co.* Lat. 40° 29′; lon. 93° 03′. The station is on an open square 562 ft. N.W. of the W. corner of the court-house square and 150 ft. N.W. of the same. These measurements are made along the streets which lie diagonally in reference to the points of the compass. The sky was again cloudy at elongation, and polaris was observed at 9 h. 11 m. and 10 h. 46 m.

STATION 136—*In Sullivan Co.* Lat. 40° 19′; lon. 93° 07′. On the farm of Nathan Bankes, on the N.E. qr. of the S.E. qr. of sec. 28, tp. 64, r. 19 W. The station is in the meadow 26 ft. S. of the S.W. corner of Bankes' house and 249 ft. W. of the middle of the road. Polaris obs. on elongation.

STATION 137—*Milan, Sullivan Co.* Lat. 40° 12′; lon. 93° 11′. On the common, 160 ft. S. of the S.W. corner of the public school building. Polaris obs. on elongation.

STATION 138—*Sticklerville, Sullivan Co.* Lat. 40° 09′; lon. 92° 58′. Near the S.W. corner of the N.W. qr. of sec. 22, tp. 62, r. 18 W. The N. W. corner of the church bears S. 31° 15′ W., and is distant 731 ft. The same corner of the church is 137 ft. S.E. of the qr. sec. corner before mentioned. Polaris obs. not at elongation.

STATION 139—*Kirksville, Adair Co.* Lat. 40° 12′; lon. 92° 37′. In a vacant lot, owned by Dr. Hurley, on the S.W. corner of Fifth and Fillmore sts., 76 ft. from the centre of the latter and 83 ft. from the centre of the former street. The left side of the tower of the State Normal school building bears S. 69° 02′.5 E. Polaris obs. on elongation.

STATION 140—*La Plata, Macon Co.* Lat. 40° 00′; lon. 92° 34′. Station in the street about midway between the track and the N. fence. The middle, E. and W. line of sec. 7, tp. 60, r. 14 W., is 486 ft. N., and the E. line of the section is 637 ft. E. These distances were measured along the streets. The house of B. F. Bragg is on the S. side of the street, a little E. of the station. Polaris obs. on elongation.

STATION 141—*In Macon Co.* Lat. 39° 53′; lon. 92° 22′. Station on Bear creek bottom, 304 ft. N. and 832 ft. E. of the middle of the S. line of sec. 23, tp. 59, r. 13 W., near Harris's farm. Some error was made in reading the verniers in the star observation. It is conjectured that the altitude was read too high by 10′. This conjecture is baesd on observations at the next station, made at elongation and an equal interval after elongation, allowance being made for the change in latitude.

In the magnetic determination on the morning of the 12th marked disturbances of the needle were observed. The declination diminished 9′ between 6 and 7 o'clock.

STATION 142—*In Shelby Co.*, 3 miles S. of Shelbyville. Lat. 39° 44′; lon. 92° 04′. The middle stone on the N. line of sec. 5, tp. 57, r. 10 W., bears N. 4°, 50′ E., and is distant 910 ft. Polaris obs. on elongation.

STATION 143—*In Monroe Co.*, on the farm of Henry Winkler, 40 ft. E. of the centre of the road, and 669 ft. N. of the S. line of sec. 35, tp. 56, r. 10 W. The road, which runs N. and S., divides the S.W. qr. of the section in halves. Polaris obs. on elongation.

STATION 144—*In Monroe Co.* Lat. 39° 22′; lon. 91° 59′. On the summit of the S. bluff of Long Branch of Salt river, W. of the road, on land of B. F. Dowell. The land is in sec. 30, tp. 53, r. 9 W. The station was about 75 ft. W. of the road, which is on the E. line of the section. The Baptist church across the road is about 50 ft. farther S. than the station. These measurements were forgotten, and the distances were estimated the same day after having left the locality. Polaris observation on elongation.

STATION 145—*Montgomery City.* Lat. 39° 00′; lon. 91° 30′. The station is 105 ft. W. of the middle (N. and S.) line of the S.E. qr. of sec. 32, tp. 49, r. 5 W., and a perpendicular laid off to the track of the Wabash-

Pacific R.R. track measures 200 ft. Passing freight trains caused the needle to swing through 2′. Polaris obs. on elongation.

STATION 146—*Warrenton, Warren Co.* Lat. 38° 46′; lon. 91° 08′. The station is at the W. end of town, about a mile from the station of 1881. Starting at the creek bridge W. of the court-house, the station will be found by going along the road westwardly 705 ft., thence southwardly at right angles to the road a distance of 45 ft. The court-house spire bears S. 79° $14._8$′ E. Polaris obs. on elongation.

STATION 147—*In St. Charles Co.* Lat. 38° 43′; lon. 90° 40′. The station is in the Booneslick road about midway between the track and the S. fence, and almost due south of O'Fallon.* The O'Fallon road is 250 ft. E. The house of D. Heald lies a few rods to the W. Polaris observation on elongation.

STATION 148—*In St. Louis Co.* Lat. 38° 41′; lon. 90° 21′. On the St. Charles rock road. The station was in a gap in the fence opposite the grounds of J. B. Lucas. From the station to the centre of the road the distance is 30 ft. From thence along the road to a point opposite the gate is 165 ft., while the distance in the opposite direction to a point opposite the S.E. corner of the Lucas grounds is 158 ft. Polaris observation on elongation.

STATION 149—*Near Atalissa, Muscatine Co., Iowa*, on the farm of Mrs. Grace Aikins, on the N.E. qr. of the N.W. qr. of sec. 3, tp. 78, r. 3 W. The station is on the front path, exactly between the front gate and the house. This station is a mile west of station 33 in the report of 1880.† Polaris obs.

STATION 34—This station was occupied in 1880, and is described in the report for that year. Polaris obs. on elongation.

At six of the stations of the summer deflection determinations were made with the University magnetometer, with magnet C_6 deflecting and C_{17} deflected, and these observations have been used in determining the value of *P*, and in calculating the magnetic moment of C_6 for the summer. The latter was sensibly constant, the observed difference between the extreme value observed and the mean of all being about $0._{0005}$ of the average moment. In the reduction of the work the magnetic moment was therefore assumed to be constant. The calculations for *P* and for the magnetic moment are given in the adjoining tables.

* In the report for 1880 the lon. of O'Fallon should be 99° 40′.

† Station 33 is on the N.E. qr. of the N.W. qr. of sec. 2, and not N.E. qr. of N.E. qr. as was given in the report of 1880.

Determination of *P* for the Summer of 1882.

Station.	Date.	LOGARITHMS. $r^3 \tan u$.	$r'^3 \tan u'$.	$r \tan u$.	$r' \tan u'$.	A.	B.	$\frac{A}{B}$	P.
Kirkwood......	June 17	9.49088	9.48780	8.88882	9.00183	7.34242 *p*	8.36211 *n*	8.98031 *n*	— 0.0956
Goebel's.......	" 21	9.48396	9.48699	8.88190	9.00092	7.33041 *n*	8.38057 *n*	8.94984 *p*	+ 0.0891
Centralia......	July 5	9.49880	9.49785	8.89674	9.01178	6.83885 *p*	8.37858 *n*	8.46027 *n*	— 0.0289
Linneus.......	" 14	9.51036	9.51033	8.90830	9.02426	5.47712 *p*	8.39393 *n*	7.08319 *n*	— 0.0012
Kingston......	" 22	9.50580	9.50984	8.90374	9.02377	7.47422 *n*	8.40671 *n*	9.06751 *p*	+ 0.1168
Trenton.......	Aug. 1	9.51217	9.51383	8.91011	9.02776	7.09342 *n*	8.40312 *n*	9.69030 *p*	+ 0.0490
								Mean........	+ 0.0215

Magnetic Moment of C_6 for Summer of 1882.

Station.	Date.	t.	$t-80.7$	$\log 1+(t-80.7)q$.	$\log m_t$.	$\log m$.	Days.	d.	$y = \log m_0 - \log m$	yd.	d^2.
Kirkwood.....	June 17	86.5	+ 6.5	0.00121	9.86290	9.86411	0	—26	+ 0.00004	—0.00104	676
Goebel's.......	" 21	90.8	+10.1	0.00211	9.86165	9.86376	4	—22	+ 0.00039	—0.00858	484
Centralia.....	July 5	77.1	— 3.6	9.99924	9.86447	9.86371	18	— 8	+ 0.00044	—0.00352	64
Linneus.......	" 14	76.5	— 4.2	9.99912	9.86568	9.86480	27	+ 1	— 0.00065	—0.00065	1
"	" 15	70.0	—10.7	9.99776	9.86565	9.86341	28	+ 2	+ 0.00074	+0.00148	4
Kingston......	" 22	82.5	+ 1.8	0.00037	9.86476	9.86513	35	+ 9	— 0.00098	—0.00882	81
Trenton.......	Aug. 1	81.0	+ 0.3	0.00003	9.86440	9.86446	45	+19	— 0.00031	—0.00589	361
"	" 1	81.4	+ 0.7	0.00014	9.86370	9.86384	45	+19	+ 0.00031	+0.00589	361
	Means	80.7			$\log m_0 =$	9.86415	26		Sums	—0.02113	2032

The value of P, as determined in the first of the tables, gives for the value of $1 - \frac{P}{r^2}$ the values

$$1 - \frac{P}{2^2} = 0.9946 \quad \log = 9.99765$$

$$1 - \frac{P}{(1.75)^2} = 0.9930 \quad \log = 9.99695$$

These values were used in the reduction of the deflection series made for the determination of the magnetic moment of magnet C_6.

In the second table, the decrease (a) in the value of log m is determined, and it is found that for the summer of 1882, and at a temperature of 80.7, the value of (a) is

$$a = \frac{-0.02113}{2032} = -0.000,009,$$

or $$\log m = 9.86415 + 0.000,009\, d,$$

where d is estimated in days from July 13. The value of log m was therefore considered constant during the summer.

In all of the intensity determinations the time of vibration was determined by means of a Waltham watch belonging to Mr. Ringling. This watch had been cleaned just before leaving St. Louis, but it had not been rated. The error of the watch was determined, at intervals during the summer, by comparison with clock-beats from the observatory of Washington University, transmitted daily to the telegraph lines of various railways in the State. Its rate during the summer was a loss of 20 seconds per day, fluctuating however between 17 and 22 seconds. The correction on the time of vibration was + 0.0016 second at all the stations, the time of vibration at the stations not varying sufficiently to change the value of this correction. The effect of neglecting this correction altogether would be equivalent to the effect of an error of half a degree in temperature.

The intensity determinations were all made with magnet C_6 in the University declinometer, C_{17} being used as a deflected magnet. The moment of inertia of C_6 was obtained from the table given in the 4th report.* The values for H are not corrected for

* Trans. vol. iv. No. 3, p. 468.

the effect of magnetic brass-work of the magnetometer. This correction is given in the 4th report, p. 472.

The observations for inclination were not very satisfactory, as the axes of the needles were both bent during the early part of the summer.

The following observations for meridian, by equal altitudes of the sun, were made. The method of reduction has been explained in previous reports.

Sun Observations for Meridian.

Station.	Date.	No. of Obs.	Mean Time of Series. A. M.	Mean Time of Series. P. M.	t.	½ $(A+A')$.
			h. m. s.	*h. m. s.*	*deg. m.*	*deg. m.*
Little Auxvasse Cr.	June 30	5	9 36 58	2 32 40	37 03.7	244 56.7
Honan's	July 30	2	9 38 25	2 23 18	35 42.5	176 38.5

log $\Delta d''$.	a. c. log cos φ.	a.c. log sin t	Cor.	South reads	Mark reads	Az. of Mark.
1.67112	0.10777	0.21992	+ 0′ 8	244° 57′.5	180°02′.0	S. 64°55.5 E.
2.23805	0.11660	0.23384	+ 3 2	176 41 .7	180 01 .2	S. 3 19.5 W.

Polaris Observations for Meridian.

Station.	Lat. ϕ.	Alt. h.*	Polar D. p.	½ Sum = S.
Daviess Co., Sta. 129.	40° 04′	39° 42′.5	1° 19′.3	40° 32′.9
Amick's	40 13	39 34 .0	"	40 33 .1
"	"	39 46 .0	"	40 39 .2
Princeton	40 24	39 58 .0	"	40 50 .6
"	"	40 05 .0	"	40 54 .2
Ward's	40 27	40 48 .0	"	41 17 .2
Unionville	40 29	40 12 .5	"	41 00 .4
"	"	40 45 .5	"	41 16 .9
Sticklerville	40 09	39 37 .0	"	40 32 .7
"	"	39 46 .5	"	40 37 .4
Harris's	39 53	40 25 .0†	"	40 48 .6

* The altitudes are all corrected for refraction.

† This altitude was recorded 40° 36′.0. It should have been 40° 26′, as was determined at the next station (Shelbyville) by an observation made the same time interval after elongation.

Reduction Polaris Observations.

Station.	a. c. cos. S.	a. c. cos. $(S-p)$.	sin $(S-h)$.	sin $(S-\varphi)$.	$\tan^2 \frac{1}{2} A$.	A.	Polaris reads.	North reads.	Mark reads.	Azimuth of Mark.
Daviess Co. (St. 29)	0.11932	0.11094	8.16181	7.93231	16.32438	1°39′ .8	180°00′ .7	178°20′ .9	None used	....
Amick's	0.11929	0.11091	8.23529	7.76687	16.23236	1 29 .8	329 55 .5	328 25 .7	180°00′ .7	S. 31°35′ .0 W.
"	0.11995	0.11155	8.18962	7.88202	16.30314	1 37 .4	330 03 .0	328 25 .6	180 00 .7	S. 31 35 .1 W.
Princeton	0.12119	0.11273	8.18470	7.88861	16.30723	1 37 .9	309 41 .0	308 03 .1	180 01 .7	S. 51 58 .6 W.
"	0.12158	0.11310	8.15567	7.94372	16.33407	1 41 .0	309 44 .0	308 03 .0	180 01 .7	S. 51 58 .7 W.
Ward's	0.12412	0.11552	7.92910	8.16441	16.33315	1 40 .9	309 53 .7	358 12 .8	None used	....
Unionville	0.12226	0.11375	8.14405	7.96065	16.34071	1 41 .6	251 53 .2	250 11 .6	180 00 .7	S. 109 49 .1 W.
"	0.12418	0.11549	7.96065	8.14405	16.34437	1 42 .2	251 55 .7	250.13 .5	180 00 .7	S. 109 47 .2 W.
Sticklerville	0.11975	0.11087	8.17043	7.91704	16.31858	1 39 .1	329 41 .5	328 02 .4	180 00 .5	S 31 58 .1 W.
"	0.11925	0.11136	8.20956	7.83848	16.27806	1 34 .6	329 36 .5	328 01 .9	180 00 .5	S. 31 58 .6 W.
Harris's	0.12097	0.11256	7.83664	8.20878	16.27895	1 34 .8	312 11 .2	310 36 .4	180 01 .0	S. 49 24 .6 W.

Polaris Observations on Elongation for Meridian.

Station.	Azim. Circle. Vernier A.		Azimuth of Elongation	North reads	Azimuth of Mark S.	Remarks.
	Mark reads	Polaris reads				
Kirkwood	359°·59′8	328°51′·0	1°41′·2	327°09′·8	147°10′·0 E.	
Gray's Summit	180 00 ·7	92 57 ·0	1 41 ·2	91 16 ·6	91 15 ·9 E.	
Newport	180 01 ·2	210 40 ·0	1 41 ·2	208 58 ·8	151 02 ·4 W.	
Goebel's	180 00 ·7	97 08 ·0	1 40 ·9	95 27 ·1	95 26 ·4 E.	
Ruck's	180 01 ·0	4 34 ·5	1 41 ·7	2 52 ·8	2 52 ·5 E.	
Bruns'	180 01 ·0	357 27 ·7	1 41 ·2	355 46 ·5	4 14 ·5 W.	
"	180 01 ·2	357 28 ·5	1 41 ·2	355 47 ·3	4 14 ·9 W.	No morning mark reading.
Kaldeweiher's	180 01 ·7	133 56 ·5	1 41 ·2	132 15 ·3	132 13 ·8 E.	
Linn	180 00 ·7	52 13 ·0	1 41 ·2	50 31 ·8	50 31 ·1 E.	
Little Auxvasse Creek	180 00 ·7	66 40 ·3	1 41 ·7	64 58 ·6	64 57 ·9 E.	
Stephen's Store	180 01 ·5	158 07 ·5	1 42 ·0	156 25 ·5	156 24 ·0 E.	
Centralia	180 00 ·7	92 27 ·2	1 42 ·4	90 44 ·8	90 44 ·1 E.	
Long Branch	180 00 ·7	177 10 ·5	1 43 ·0	175 27 ·5	175 26 ·8 E.	
Moberly	180 00 ·7	237 08 ·7	1 43 ·0	235 25 ·7	124 35 ·0 W.	No morning mark reading.
Macon	180 01 ·2	319 48 ·7	1 43 ·1	318 05 ·6	41 55 ·6 W.	
Lewis'	180 01 ·2	294 58 ·0	1 43 ·1	293 14 ·9	66 46 ·3 W.	
Mercyville	180 00 ·7	349 49 ·7	1 43 ·5	348 06 ·2	11 54 ·5 E.	
Yellow Creek	180 00 ·7	302 19 ·2	1 43 ·4	300 35 ·8	59 24 ·9 E.	
Linneus	180 01 ·2	242 11 ·5	1 43 ·3	240 28 ·2	119 33 ·0 W.	
"	180 00 ·7	242 11 ·5	1 43 ·3	240 28 ·2	119 32 ·5 W.	
Laclede	180 01 ·0	62 02 ·5	1 43 ·1	60 19 ·4	60 18 ·4 E.	
Wolford's	180 00 ·7	270 40 ·0	1 42 ·9	268 57 ·1	91 03 ·6 W.	
Kingston	180 00 ·7	98 17 ·7	1 43 ·0	96 34 ·7	96 34 ·0 E.	
Smitt's	180 00 ·7	66 45 ·5	1 42 ·9	65 02 ·6	65 01 ·9 E.	

Maysville	180 00 .7	200 07 .0	1 43 .0	198 24 .0	61 36 .7 W.	
Johnson's	180 00 .7	44 58 .5	1 43 .5	43 15 .0	43 14 .8 E.	
Albany	180 00 .7	187 45 .5	1 43 .4	186 02 .1	173 58 .6 W.	
Near Albany	13 54 .0	101 30 .7	1 43 .4	99 47 .3	94 06 .7 W.	No evening mark reading.
Trenton	180 00 .5	156 11 .6	1 43 .5	154 28 .0	154 27 .5 E.	
Williams'	....	179 57 .0	1 44 .4	178 12 .6	....	No mark used.
Bankes'	180 00 .5	114 38 .5	1 44 .0	112 54 .5	112 54 .0 E.	No morning mark reading.
Milan	180 00 .5	166 05 .2	1 43 .8	164 21 .4	164 20 .9 E.	
Sticklerville	180 00 .5	329 47 .0	1 43 .9	328 03 .1	31 57 .4 W.	See previous table.
Kirksville	180 01 .2	70 47 .5	1 43 .8	69 03 .7	69 02 .5 E.	
La Plata	180 01 .0	91 07 .0	1 43 .5	89 23 .5	89 22 .5 E.	
Shelbyville	....	179 49 .7	1 43 .1	178 06 .6	....	No mark used.
Winkler's	....	180 03 .7	1 42 .8	178 20 .9	....	" " "
Long Branch*	180 01 .0	94 22 .3	1 42 .4	92 39 .9	92 38 .9 E.	
Montgomery City	180 00 .7	245 53 .2	1 42 .0	244 11 .2	115 49 .5 W.	
Warrenton	180 00 .5	80 57 .0	1 41 .7	79 15 .3	79 14 .8 E.	
Heald's	....	180 00 .7	1 41 .7	178 19 .0	....	No mark used.
Lucas'	165 54 .2	180 00 .7	1 41 .7	178 19 .0	167 35 .2 W.	No evening mark reading.
G. Aikins'	180 00 .5	69 53 .5	1 46 .0	68 07 .5	68 07 .0 E.	No morning " "
E. Aikins'	180 01 .0	1 27 .5	1 46 .0	359 41 .5	0 19 .0 W.	

* Near Long Branch Post-office and about 12 miles east of station 112.

Magnetic Declination or "Variation."

STATIONS.	MAGNET SCALE. Elongations. East.	West.	Mean.	Axis reads.	Reduction to Axis.	AZIMUTH CIRCLE. Circle reads	Magnetic South reads	Mark reads	True South reads	DECLINATION. Uncorrected.	Corrected.	Date.
Kirkwood	82d 5	76d 25	79d ·37	78d ·24	+2′ ·2	153°29′ ·7	153°31′ ·9	359 59′ ·8	147°09′ ·8	6°22′ ·1	6°24′ ·1	Jun. 17
Gray's Summit ..	80·0	*	76 ·3	78 ·2	—3 ·6	278 13 ·0	278 09 ·4	180 01 ·0	271 16 ·9	6 52 ·5	6 54 ·5	" 19
Newport	80·3	74·1	77 ·2	[78 ·2]	—1 ·9	35 58 ·5	35 56 ·6	180 02 ·0	28 59 ·6	6 57 ·0	6 59 ·0	" 20
Goebel's..........	80·2	75·5	77 ·8	78 ·2	—0 ·8	283 04 ·0	283 03 ·2	180 00 ·5	275 26 ·9	7 36 ·3	7 38 ·3	" 22
Ruck's............	81·9	*	78 ·2	[78 ·2]	0 ·0	190 42 ·8	190 42 ·8	180 01 ·2	182 53 ·7	7 49 ·1	7 51 ·1	" 24
Bruns'............	80·8	74·9	77 ·8	[78 ·2]	—0 ·8	182 37 ·8	182 37 ·0	180 01 ·2	175 46 ·6	6 50 ·4	6 52 ·4	" 25
Kaldeweiher's.....	80·0	*	76 ·3	[78 ·2]	—3 ·6	320 01 ·2	319 57 ·6	180 01 ·5	312 15 ·3	7 42 ·3	7 44 ·3	" 27
Linn	81·5	*	77 ·8	[78 ·2]	—0 ·8	238 07 ·5	238 06 ·7	180 00 ·7	230 31 ·8	7 34 ·9	7 36 ·9	" 28
Little Auxvasse ...	81·4	75·9	78 ·7	77 ·9	+1 ·5	252 51 ·0	252 52 ·5	180 01 ·2	244 59 ·1	7 53 ·4	7 55 ·4	" 30
Stephen's Store ...	81·6	74·4	78 ·0	[77 ·9]	+0 ·2	344 00 ·7	344 00 ·9	180 02 ·2	336 26 ·2	7 34 ·7	7 36 ·7	July 3
Centralia	82·5	74·5	78 ·5	[77 ·9]	+1 ·1	278 38 ·8	278 39 ·9	180 00 ·7	270 44 ·8	7 55 ·1	7 57 ·1	" 5
Long Branch	82·6	*	78 ·9	[77 ·9]	+1 ·9	363 31 ·0	363 32 ·9	180 01 ·6	355 28 ·4	8 04 ·5	8 06 ·5	" 6
Moberly	83·2	77·55	80 ·4	[77 ·9]	+4 ·8	62 58 ·5	63 03 ·3	180 00 ·7	55 25 ·7	7 37 ·6	7 39 ·6	" 7
Macon............	81·0	*	77 ·3	[77 ·9]	—1 ·1	146 04 ·2	146 03 ·1	180 01 ·7	138 06 ·1	7 57 ·0	7 59 ·0	" 9
Lewis'............	81·0	*	77 ·3	[77 ·9]	—1 ·1	121 13 ·5	121 12 ·4	182 02 ·0	113 15 ·7	7 56 ·7	7 58 ·7	" 10
Mercyville	81·2	75·3	78 ·3	[77 ·9]	+0 ·8	176 19 ·7	176 20 ·5	180 00 ·0	168 05 ·5	8 15 ·0	8 17 ·0	" 11
Yellow Creek	80·5	*	76 ·8	[77 ·9]	—2 ·1	128 54 ·5	128 52 ·4	180 03 ·2	120 38 ·3	8 14 ·1	8 16 ·1	" 13
Linneus	81·2	75·7	78 ·5	78 ·1	+0 ·6	68 22 ·2	68 22 ·8	180 01 ·2	60 28 ·2	7 54 ·6	7 56 ·6	" 14
"	80·3	73·3	76 ·8	[78 ·1]	—2 ·5	68 24 ·7	68 22 ·2	180 01 ·5	60 29 ·0	7 53 ·2	7 55 ·2	" 15
Laclede	80·1	*	76 ·4	[78 ·1]	—3 ·2	248 31 ·0	248 27 ·8	180 00 ·7	240 19 ·1	8 08 ·7	8 10 ·7	" 17
Wolford's.........	81·2	74·4	77 ·8	[78 ·1]	—0 ·6	97 35 ·7	97 35 ·1	180 00 ·7	88 57 ·1	8 38 ·0	8 40 ·0	" 20
Kingston	81·2	73·0	77 ·1	[78 ·1]	—1 ·9	285 46 ·7	285 44 ·8	180 00 ·7	276 34 ·7	9 10 ·1	9 12 ·1	" 22

Smitt's	79.9	*	76.2	77 .9	—3 .2	254 40 .7	254 37 .5	180 00 .7	245 02 .6	9 34 .9	9 36 .9	July 23
Maysville	81.0	7.60	78.5	[77 .9]	+1 .1	27 39 .0	27 40 .0	180 00 .7	18 24 .0	9 16 .0	9 18 .0	" 24
Johnson's	81.6	*	77.9	[77 .9]	0 .0	232 47 .5	232 47 .5	180 01 .5	223 16 .3	9 31 .2	9 33 .2	" 25
Albany	80.9	74.7	77.8	[77 .9]	—0 .2	14 26 .5	14 26 .3	180 00 .9	6 02 .3	8 24 .0	8 26 .0	" 26
Near Albany	80.9	*	77.2	[77 .9]	—1 .4	288 20 .0	288 18 .6	13 54 .1	279 47 .4	8 31 .2	8 33 .2	" 27
Bethany	80.7	74.7	77.7	[77 .9]	—0 .4	255 52 .7	255 52 .3	179 59 .7	247 10 .8	8 41 .5	8 43 .5	" 28
Honan's	80.8	72.0	76.4	[77 .9]	—2 .8	185 30 .5	185 27 .7	180 01 .2	176 41 .7	8 46 .0	8 48 .0	" 30
Daviess Co., st. 129	81.2	*	77.5	[77 .9]	—0 .8	70 06 .0	7 05 .2	none used	358 20 .9	8 44 .3	8 46 .3	" 31
Trenton	81.0	76.0	78.5	[77 .9]	+1 .1	342 28 .7	342 29 .8	180 00 .4	334 29 .9	8 01 .9	8 03 .9	Aug. 1
Amick's	80.1	*	76.4	[77 .9]	—2 .9	156 50 .0	156 47 .1	180 00 .7	148 25 .7	8 21 .4	8 23 .4	" 2
Princeton	81.0	*	77.3	[77 .9]	—1 .1	136 52 .0	136 50 .9	180 02 .7	128 05 .5	8 45 .4	8 47 .4	" 3
Williams'	81.0	*	77.3	[77 .9]	—1 .1	6 50 .5	6 49 .4	none used	358 12 .6	8 36 .8	8 38 .8	" 4
Ward's	80.4	*	76.7	[77 .9]	—2 .3	186 42 .2	186 39 .9	"	178 12 .8	8 27 .1	8 29 .1	" 5
Unionville	*	75.2	78.9	77 .6	+2 .5	78 11 .2	78 13 .7	180 01 .0	70 11 .9	8 01 .8	8 03 .8	" 5
"	80.0	*	76.3	[77 .6]	—.2 .4	78 10 .0	78 07 .6	180 00 .9	70 11 .8	7 55 .8	7 57 .8	" 6
Bankes'	82.0	*	78.3	[77 .6]	+1 .3	301 31 .5	301 32 .8	180 03 .0	292 57 .0	8 35 .8	8 37 .8	" 7
Milan	81.1	*	77.4	[77 .6]	—0 .4	352 38 .0	352 37 .6	179 59 .8	344 20 .7	8 15 .9	8 17 .9	" 8
Sticklerville	80.7	*	77.0	[77 .6]	—1 .1	156 53 .7	156 52 .6	180 00 .5	148 02 .6	8 50 .0	8 52 .0	" 9
Kirksville	80.1	*	76.4	[77 .6]	—2 .3	257 21 .0	257 18 .7	180 01 .7	249 04 .2	8 14 .5	8 16 .5	" 10
La Plata	80.5	*	76.8	[77 .6]	—1 .5	277 32 .7	277 31 .2	180 01 .5	269 24 .0	8 07 .2	8 09 .2	" 11
Harris'	82.0	*	78.3	[77 .6]	+1 .3	138 10 .5	138 11 .0	180 01 .5	130 36 .9	†7 34 .9	7 36 .9	" 12
Shelbyville	80.7	*	77.0	[77 .6]	—1 .1	5 52 .7	5 51 .6	none used	358 06 .6	7 45 .0	7 47 .0	" 13
Winkler's	81.8	*	78.1	[77 .6]	+0 .9	6 02 .5	6 03 .4	"	358 20 .9	7 42 .5	7 44 .5	" 14
Long Branch	81.5	*	77.8	[77 .6]	+0 .4	280 37 .5	280 37 .9	180 01 .2	272 40 .1	7 57 .8	7 59 .8	" 15
Montgomery City.	82.4	*	78.7	[77 .6]	+2 1	71 14 .5	71 16 .6	180 01 .0	64 11 .5	7 05 .1	7 07 .1	" 17
Warrenton	81.5	*	77.8	[77 .6]	+0 .4	265 46 .7	265 47 .1	180 00 .5	259 15 .3	6 31 .8	6 33 .8	" 18
Heald's	81.7	*	78.0	[77 .6]	+0 .7	365 02 .7	365 03 .4	none used	358 19 .0	6 44 .4	6 46 .4	" 19
St. Charles	81.6	*	77.9	[77 .6)	+0 .6	364 24 .7	364 25 .3	....	358 19 .0	6 06 .3	6 08 .3	" 20
G. Aikins'	81.2	*	77.5	77 .8	—0 .6	255 28 .2	255 27 .6	180 00 .5	248 07 .5	7 20 .1	7 22 .1	" 26
"	*	75.0	78.7	[77 .8]	+1 .8	255 22 .7	255 24 .5	180 00 .7	248 07 .7	7 16 .8	7 18 .8	" 27
E. Aikins'	80.5	71.5	76.0	[77 .8]	—3 .5	187 31 .5	187 28 .0	180 00 .6	179 41 .6	7 46 .4	7 48 .4	" 29

* Only one elongation taken. See 4th report, Trans. vol. iv., No. 3, p. 454.

† See description of this station, No. 141.

Intensity — Oscillations.

STATION.	Date.	t'. Temp.	LOGARITHMS. T'^2.	$1+\frac{h}{f}$	$1-(t'-t)q$	T^2.	k.	mH.	H.	H.
Kirkwood	June 17	86°.5	1.67682	0.00034	9.99886	1.67602	1.22331	0.54159	0.67869	4.772
Goebel's	" 21	90 .8	1.67582	0.00046	9.99788	1.67416	1.22339	0.54353	0.68188	4.807
Linn	" 27	90 .6	1.67310	0.00034	9.99792	1.67136	1.22338	0.54632	0.68217	4.810
Auxvasse Creek	" 30	90 .0	1.67800	0.00032	9.99806	1.67638	1.22337	0.54129	0.67714	4.755
Stephen's Store	July 3	91 .2	1.67630	0.00032	9.99781	1.67443	1.22339	0.54326	0.67911	4.777
Centralia	" 5	77 .1	1.68216	0.00036	0.00075	1.68327	1.22315	0.53418	0.67003	4.678
Moberly	" 7	80 .0	1.68802	0.00036	0.00015	1.68853	1.22320	0.52897	0.66482	4.622
"	" 7	100 .2	1.69250	0.00028	9.99590	1.68860	1.22354	0.52916	0.66501	4.624
Mercyville	" 11	75 .5	1.68926	0.00037	0.00108	1.69071	1.22313	0.52672	0.66257	4.598
Linneus	" 14	76 .5	1.69238	0.00042	0.00087	1.69367	1.22314	0.52377	0.65962	4.567
"	" 15	70 .0	1.69130	0.00032	0.00225	1.69387	1.22303	0.52346	0.65931	4.564
Wolford's	" 20	78 .2	1.68910	0.00034	0.00051	1.68995	1.22317	0.52752	0.66337	4.607
Kingston	" 22	82 .5	1.69306	0.00046	9.99962	1.69314	1.22324	0.52440	0.66025	4.574
Maysville	" 24	86 .2	1.68948	0.00027	9.99886	1.68861	1.22330	0.52899	0.66484	4.622
Albany	" 26	83 .7	1.69680	0.00034	9.99937	1.69651	1.22326	0.52105	0.65690	4.537
Bethany	" 27	82 .1	1.69764	0.00036	9.99971	1.69771	1.22323	0.51982	0.65567	4.525
Trenton	Aug. 1	81 .0	1.69790	0.00028	9.99994	1.69812	1.22322	0.51940	0.65525	4.521
"	" 1	82 .7	1.69866	0.00028	9.99958	1.69852	1.22324	0.51902	0.65487	4.517
Princeton	" 2	76 .5	1.69774	0.00035	0.00087	1.69896	1.22314	0.51848	0.65433	4.512
Unionville	" 5	75 .6	1.70110	0.00032	0.00106	1.70248	1.22313	0.51495	0.65080	4.475
Milan	" 7	83 .0	1.69916	0.00025	9.99956	1.69897	1.22325	0.51858	0.65443	4.523

Intensity — Deflections.

Station.	Date.		t.	r ft.	Logarithms.			
					$u^{div.}$	$1 + \frac{h}{f}$	Corrected tan u.	m.
Kirkwood	June	17	89.6	2.00	1.66214	0.00080	8.58779	9.18750
"	"	17	86.3	1.75	1.83294	0.00074	8.75879	9.18382
Goebel's	"	21	90.1	2.00	1.65528	0.00075	8.58087	9.18058
"	"	21	90.0	1.75	1.83203	0.00075	8.75788	9.18291
Centralia	July	5	77.8	2.00	1.66992	0.00094	8.59571	9.19542
"	"	5	81.6	1.75	1.84267	0.00094	8.76874	9.19369
Linneus	"	14	75.2	2.00	1.68147	0.00094	8.60727	9.20698
"	"	14	74.8	1.75	1.85513	0.00094	8.78122	9.20625
Kingston	"	22	74.4	2.00	1.67710	0.00075	8.60271	9.20242
"	"	22	77.1	1.75	1.85506	0.00052	8.78073	9.20576
Trenton	Aug.	1	84.1	2.00	1.68352	0.00070	8.60908	9.20879
"	"	1	85.8	1.75	1.85878	0.00077	8.78472	9.20975

INCLINATION, OR DIP.

Needle No 2.

STATION.	Marked End.		Means by Polarities.		Resulting Dip.	Date.
	North.	South.	Series I.	Series II.		
Kirkwood*	68°59′.9	66°44′.9	69°01′.1	66°48′.8	67°52′.4	June 17
Goebel's..................	68 53 .4	69 18 .1	68 58 .6	69 12 .8	69 05 .7	" 22
Linn	68 35 .0	68 58 .8	68 39 .0	68 54 .7	68 46 .9	" 27
Little Auxvasse Cr'k.	68 50 .6	69 19 .5	68 54 .5	69 15 .6	69 05 .0	" 30
Centralia............ . .	69 26 .2	69 48 .2	69 44 .6	69 29 .6	69 37 .2	July 5
Moberly..................	65 25 .2	69 45 .4	69 30 .1	69 37 .8	69 35 .3	" 7
Mercyville	69 54 .4	70 07 .5	69 57 .0	70 04 .8	70 00 .9	" 11
Linneus	69 51 .4	70 10 .0	69 53 .0	70 08 .5	70 00 .7	" 15
Wolfort's*.......... ...	70 41 .2	71 07 .4	70 34 .9	71 13 .7	70 54 .3	" 20
Kingston.................	70 04 .8	70 15 .4	70 05 .2	70 14 .8	70 10 .1	" 22
Maysville.................	69 34 .4	69 51 .9	69 33 .8	69 52 .5	69 43 .2	" 24
Albany.......	70 04 ·6	70 25 .4	70 08 .8	70 21 .2	70 15 .0	" 26
Bethany..................	70 04 .9	70 29 .0	70 12 .0	70 21 .9	70 16 .9	" 27
Trenton..................	70 04 .8	70 24 .8	70 04 .4	70 25 .2	70 14 .8	Aug. 1
Princeton	70 13 .6	70 30 .0	70 16 .2	70 27 .4	70 21 .8	" 2
Unionville..............	70 23 .6	70 05 .4	70 20 .6	70 08 .4	70 14 .5	" 5
Milan	70 05 .8	70 27 .9	70 10 .2	70 23 .4	70 16 .8	" 8

* Some error.

Needle No. 3.

STATION.	Marked End.		Means by Polarities.		Resulting Dip.	Date.
	North.	South.	Series I.	Series II.		
Kirkwood...............	69°34′.7	69°15′.7	70 39′.5	68°10′.9	69°25′.2	June 17
Goebel's..................	69 19 .1	68 48 .4	68 15 .8	69 51 .6	69 03 .7	" 22
Little Auxvasse Cr'k.	67 34 .8	68 43 .8	68 23 .5	69 55 .1	69 09 .3	" 30
Moberly	69 54 .8	69 18 .8	68 44 .3	70 29 .3	69 36 .8	July 7
Mercyville...............	70 24 .6	69 36 .4	69 04 .4	70 56 .6	70 00 .5	" 11
Linneus	70 21 .5	69 45 .2	69 08 .8	70 57 .8	70 03 .4	" 15
Maysville	70 03 .5	69 30 .5	69 33 .2	70 00 .8	69 47 .0	" 24
Bethany..................	70 52 .9	69 59 .8	70 27 .8	70 24 .9	70 26 .4	" 27
Trenton	70 35 .6	69 55 .9	70 07 .4	70 24 .2	70 15 .8	Aug. 1

On the Expression of Electrical Resistance in Terms of a Velocity.

By FRANCIS E. NIPHER.*

If a spherical shell of radius r be charged with Q units of electricity, the density of electrification being ρ, the force dF over any element ds of its surface will be $2\pi\rho^2 ds$. This force is directed radially outward, and is due to the action of the electrification Q on the quantity ρds upon the element.

If the radius r be diminished to r', the energy of the electrification will increase if Q remains constant, this increase in energy being due to work done on the sphere by some external source, causing the sphere to collapse. If the element ds sweeps through a distance dr, the stored energy will be

$$dE = dF\,dr \qquad - \quad - \quad - \qquad (1)$$

in which both dF and dr are essentially negative.

Substituting in (1) the above value of dF and remembering

that
$$\rho = \frac{Q}{4\pi r^2}$$

and
$$ds = r^2\,d\omega\,,$$

where $d\omega$ is the solid angle subtended by the element ds, we have

$$dE = \frac{Q^2}{8\pi}\,\frac{dr}{r^2}\,d\omega\,,$$

or
$$E' - E = \frac{Q^2}{8\pi}\iint \frac{dr}{r^2}\,d\omega\,,$$

where one integration is carried over the surface of the sphere, and the other is carried inwards between the limits r and r'. Performing the integrations, we have

$$E' - E = \frac{Q^2}{2}\left(\frac{1}{r'} - \frac{1}{r}\right) \qquad - \quad - \qquad (2)$$

But $\frac{1}{2}\,\frac{Q^2}{r'}$ is the energy of a sphere of radius r', charged with Q units of electricity, and hence the potential of the sphere on itself between the limits r and r' is equal to the difference in its initial and final energy.

If the sphere were connected with the ground by a wire of resistance (R), the radius (r) might be changed in such a manner

* Read March 17th, 1884.

as to preserve the potential (V) constant. In this case a current of constant intensity would flow through the wire, and as $V = \frac{Q}{r}$ it is clear that r must change at a uniform rate, or

$$\frac{r - r'}{v} = t' - t \qquad - \quad - \quad - \qquad (3)$$

where $t' - t$ is the duration of the operation. Further,

$$V = \frac{Q}{r} = \frac{4\pi r^2 \rho}{r} = 4\pi r \rho$$

and

$$\rho = \frac{V}{4\pi r};$$

hence

$$dE = dF\,dr = 2\pi\rho^2\,ds\,dr = \frac{V^2}{8\pi}\,dr\,d\omega,$$

or

$$E - E' = \frac{V^2}{8\pi}\iint dr\,d\omega = \frac{V^2}{2}(r - r') \qquad - \quad - \qquad (4)$$

This is the stored energy during the operation. But the energy of the electrification at first was $\frac{1}{2}\, r V^2$, and at the end is $\frac{1}{2}\, r' V^2$, so that there has nevertheless been a diminution of energy of

$$E - E' = \frac{V^2}{2}(r - r') \qquad - \quad - \quad - \qquad (5)$$

It appears that, under conditions of our experiment, the sphere has less energy at the close of the experiment than at the beginning by a quantity $\frac{V^2}{2}(r - r')$, while the equal energy represented by the potential of the electrification on itself was added. The total energy lost by the shell was, therefore,

$$E = V^2 (r - r') \qquad - \quad - \quad - \qquad (6)$$

The current in the wire was, by Ohm's law,

$$C = \frac{dQ}{dt} = \frac{V}{R};$$

hence

$$Q - Q' = \frac{V}{R}(t' - t),$$

and hence the energy of the current during the operation was

$$E = \frac{V^2}{R}(t' - t),$$

or by (3),

$$E = \frac{V^2}{R}\,\frac{r - r'}{v} \qquad - \quad - \quad - \qquad (7)$$

The expressions (6) and (7) must be equal to each other, and hence

$$Rv = 1, \qquad \text{or} \qquad R = \frac{1}{v},$$

where v is the constant velocity of each point in the surface of the shell during the operation.

Notes about the Structure and Classification of the Pentremites.

By G. HAMBACH.

Mr. Carpenter, in criticising my paper on the Anatomy of the Blastoidea, not only expresses great doubts as to the correctness of my statements, but has the assurance to refer the results of my observations to a "wonderful power of imagination." In reply to this I will say the following:

Mr. Carpenter says on p. 419 of his paper,* I had figured and described a section of a ray of *Granatocrinus Norwoodi*, but, in spite of all advantages for examining beautiful specimens, even the original which served for my description, he is at a loss to understand the meaning. If Mr. Carpenter will go to the trouble of reading my little paper carefully, he will be convinced that the figures were not taken from *Granatocrinus Norwoodi*, but that I distinctly said, "at least in the typical ones, as *Pentremites florealis*, *sulcatus*, *pyriformis*, *etc.*"

My Fig. 9, on plate A, represents an oblique section through a fork piece and ambulacral field of *P. sulcatus*, Fig. 14 an interior view of the same, Fig. 16 an interior view of an ambulacral field alone. Both figures are taken from *P. sulcatus*, and show the longitudinal furrow of the lancet piece very well, which has been already observed and described by Roemer, p. 13.†

As to the second statement he makes, that of having examined the original serving me for my description, I must doubt very much the possibility of this, as I never send one of my type specimens away or missed them out of my collection.

That the lancet piece is perforated by a very fine canal through the centre, in its whole length, was, so far as I know, first described by me, and not by Mr. Rofe; for he takes it to be a suture, meaning that the lancet piece was composed of two pieces. Mr. Wachsmuth does not describe or figure the same in his "Palæocrinidea," Part I., but it is figured in Part II., after I had drawn attention to it. This canal, as already stated, is easily seen by

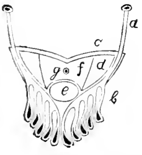
* "On certain Points in the Morphology of the Blastoidea," *Annals and Magazine of Natural History* for December, 1881.

† "Monographie der Blastoideen, 1852," and "Archiv fur Naturgeschichte," Jahrg. xvii. Bd. I.

etching the surface, or by making a cross-section through an ambulacral field, and is still more frequently preserved than I first anticipated. Further investigations prove that these canals are only the radiating rays of a pentagonal ring surrounding the central orifice. In other words, the base portion of the deltoid piece is likewise perforated transversely about midways, also the little process on the anterior base portion of the lancet piece, from where this canal runs downwards to the apex of the ambulacral field. This arrangement contradicts the existence of those so-called ovarian pores of Billings* and makes it an impossibility for them to be seen; for, if they should be seen, it is necessary to cut away a considerable portion of the summit. As these canals are perforating entirely solid calcareous substance and apparently in no direct communieation with the hydrospiric sac, I suppose that they served for the reception of the nervous system.

The "chief novelty," i. e. sublancet plate or subambulacral plate — although confirmed by Mr. Carpenter — I must deny the existence of, and would advise Mr. Carpenter, before making such assertions, to examine the matter more carefully; for the truth of the matter is, that there is no such thing as a sublancet plate, and what has been taken for it is only the upper blade of the hydrospiric sac, or the calcareous substance from the duct above it (see Fig. 1); because immediately under the lancet plate lies a duct or vessel (as already described in my paper), and under this the hydrospiric sac. I hardly deem it necessary to give a definition of the difference between the above-named organ and a sublancet plate, which latter could only mean a something like the lancet plate, only underlying it. The calcareous substance which is frequently found to fill out the duct, or the upper blade of the hydrospiric sac, which is smooth and overlays the plicas, may mislead to the supposition of having here a sublancet plate. The duct has been already described in my paper, p. 7, and the passage *b*, in Wachsmuth's Fig. 4, pt. i., of his Palæocrinoidea, is nothing more than a fissure between two hy-

Fig. 1.



TRANSVERSE SECTION OF A RESTORED AMBULACRAL FIELD:— *a*, tentacle; *b*, hydrospiric sac; *c*, integument covering ambulacral field; *d*, poral piece; *e*, duct beneath the lancet piece; *f*, lancet piece; *g*, canal perforating the same; *s*, nervous (?) canal.

* Palæozoic Fossils, vol. ii., part i., p. 102, Fig. 63.

drospiric sacs for the passage of this duct to facilitate a connection with the œsophageal ring underlying the ***annulus centralis.*** The hydrospiric sac runs from the apex of the ambulacral field to the summit, where it terminates; its plicas rest in corresponding plicas of the plicated lateral expansion of the deltoid piece, and do not unite into one tube with the adjoining ones as described and figured by Billings.* The shape in which these hydrospiric plicas are found, as well as the difference in color between them and the adjoining opaque calcareous substance of the shell, together with the physiological function ascribed to them (respiratory according to Billings), denote the once elastic nature of these organs as well as of the tentacles, which communicate with the hydrospiric sac through the poral openings, and not with any ovarian tube as Mr. Carpenter tries to misrepresent my statement. They form in their collapsed state the supplementary poral plates of Roemer, which, to the great surprise of Mr. Carpenter, are actually found preserved in an open condition from the Carboniferous period to the present time. Neither do I ignore any facts given by Rofe, Billings, Wachsmuth, or others, if they prove to be such; but in this case the marginal pores along the ambulacrum do not lead into an ovarian tube, as stated above.

Likewise is the zigzag plicated integument preserved which covers the ambulacral field, incredible as this may seem to Mr. Carpenter, whose incredulity however is no evidence to the contrary. Roemer's figure and description of *Pentremites crenulatus* do not contradict my statements, as the Doctor does not say anything in regard to this crenulation in particular; but, on the contrary, the ambulacral field which is marked ε in Roemer's Fig. 2 on Plate I. of his "Monographie der Blastoideen" indicates the existence of a layer or integument covering the same (although not described as such). The sutures, or at least the longitudinal sutures between lancet and foral pieces, would be visible if it was only a surface ornamentation of the calcareous shell as supposed by Mr. Carpenter, which is however not shown in the figure cited, nor is this suture visible in entirely well preserved specimens, of which I possess more than one in my collection. Still more, I have specimens where a partial compression of an ambulacral field has taken place, causing a distortion

* Loc. cit. p. 102, Fig. 60.

of the integument so that the parallel running plicas are bent to a sigmoid form without making any of the sutures between lancet and poral pieces visible, while, if they were only surface ornamentations, they would appear in a right angle opposite to each other and showing the sutures. Or, how would Mr. Carpenter explain the presence of those large and strange bodies in the interior of the calyx, which are frequently found in *entirely perfect* and *undisturbed bodies*, if the acute points of the integument were not flexible? Such and similar specimens. I should think, would afford sufficient proof of the correctness of my assertion.

"It is very singular," says Mr. Carpenter, that I do not "make the slightest mention of the minute plates which have been described by so many authors as covering in the ambulacral furrows of the Blastoids." It is true I did not speak about them, for the simple reason that I always found them in such a form, or condition, as to make on me the impression that they were mere accidental coverings, nor did I see any good reason for their presence.

Shumard's original specimen of *Pentremites Sayi*, which was figured by F. B. Meek,* and is now in the collection of the Washington University, proves to have only a covering of minute calcspar crystals on the summit, leavings of the surrounding matrix, which could easily be removed by applying a moist camel's-hair brush to them. The specimen figured by Mr. Wachsmuth,† also a representation of the above-named species (according to his statement), is not reliable, as Shumard's description of *Pentremites Sayi* differs very materially from that represented by him; but, as both are to represent one and the same species, one must necessarily be an incorrect one, and in this respect I think Prof. Meek deserves as much confidence as Mr. Wachsmuth. My specimens, which show a similar covering as in this last named figure, prove that the covering consists only of fragments of broken-up pinnulæ which were washed into the ambulacral furrows and remained there.

The minute plates of *Pentremites conoideus* described and figured by Shumard‡ are copied by Billings,§ with only the ovarian pores added to it (according to Billings' own statement). The

* G. C. Swallow, Geol. Survey of Missouri, 1855, Pl. B, Fig. 1 *c*.

† Palæocrinoidea, Pt. ii., 1881, Pl. xix., Fig. 3.

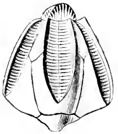
‡ Trans. of the Academy of Science of St. Louis, vol. i., 1856-60, Pl. 9, Fig. 4.

§ Loc. cit. p. 102, Fig. 63.

original specimen of this description and figure is also now in the collection of the Washington University, but it does not show anything of the remarkable structure represented in the figure. It is a specimen from Spergen Hill, Ind., and a number of specimens from the same locality as well as those from Greencastle, Ind., also a small variety found in the upper layers of the Chester or Kaskaskia limestone, frequently present the same appearance—which, however, is due to the oolitic character of the rock in which they are imbedded. This induced me to call them "ovulum-like bodies." Now, if Mr. Carpenter could explain the nature of these small ovulum-like bodies, or the origin of the so-called Oolitic limestone, he at once would know what kind of ovum I had reference to, and would probably know also whether it were partly or wholly hatched. On the other hand, he would greatly assist the science of Lithology, forasmuch as I know this question is not yet satisfactorily explained; as to the Bryozoæ, I found they are fragments belonging to the genera *Fenestella*, *Polypora*, and others, also common in this formation.

Besides these two different forms covering the summit and more or less the ambulacral furrows of the Pentremites which were first described by Dr. Shumard and subsequently by other authors (and now again by Mr. Carpenter, certainly without any improvement in the description), there is still another form mentioned by Dr. Shumard* as roofing in the summit of the calyx, but not, as misrepresented by Mr. Carpenter,, is this cone-shaped integument observed on *P. Norwoodi;* however, I do not mean

Fig. 2.



PENTREMITES SULCATUS, showing tubular pyramid on the summit.

to say that this and similar other species were never in the possession of such an organ. The only species on which Dr. Shumard observed the the same, was a specimen of *P. sulcatus* Roemer (see Fig. 2). It is so seldom found preserved, that, in thirty years' collecting, during which time I collected at one locality more than 6,000 specimens, I found only two specimens having this cone-shaped body preserved. As already stated, Dr. Shumard was the first one who made mention of it, but his description is insufficient and incorrect; so that the true

* Transactions of the Academy of Science of St. Louis, vol. i., 1856-60, p. 243-4. At this place Dr. Shumard also confounds *Elæacrinus Verneuilii* Roemer with *Pentremites*.

condition and nature are not sufficiently known. It consists of little tubes running parallel with each other and roofing in the summit of the calyx in a conical shape (but not the central opening). They protrude through the same apertures in which the hydrospires terminate; there are about five of these tubes to each aperture, which seem to correspond with the plicas of the hydrospiric sac, and, if they extend down into the interior of the calyx, as I suppose they do, then the only space which could have been occupied by them is below the hydrospiric sac and between the plicas, because they are isolated tubes and consequently not a continuation of the hydrospires. This would explain the necessity of the solid support of the plicas, which was undoubtedly to prevent an obstruction in the passage of these tubes, which I take to be the ovarian tubes.

In regard to the relationship of Echinus and Pentremites, I would say that it seems quite strange to seek for their nearest allies among the Crinoideæ; nevertheless they have been regarded and classified as a suborder to Crinodeæ, even Bronn in his "Klassen und Ordnungen des Thierreichs" puts them below the Crinoideæ, as was done by most of the authors before, and is still done by others, although Say remarks already, that "in a natural series these bodies constitute the link between the Crinoideæ and the Echinidæ."* And Mr. Carpenter certainly cannot point out a Crinoid which bears a stronger resemblance to a Pentremite than a Pentremite does to an Echinus, except those forms which ought to be classified more properly with the Blastoidea, as for instance Stephanocrinus, etc. This is especially true if we divide the test into two halves, as could be done in Pentremites, showing a striking analogy with Echinus. That portion which I had termed "dorsal half" should perhaps have been called, better, "apical" or "ambulacral system"; it would correspond to the ocular plates and ambulacral field in *Echinus*, and consists of deltoid pieces and ambulacral field in *Pentremites*. The ventral portion perhaps also had better be called actinal or interambulacral system, and would correspond to the genital plates and interambulacral field, and consist of basal plates and fork pieces in Pentremites. The growth of these two systems took place always on the apices or uppermost parts of the plates, having the centre or basis of

* Journal of the Academy of Natural Sciences of Philadelphia, vol. iv., 1825, p. 293.

their development for the one in the deltoid pieces, and for the other in the basal plates or pelvis (see Fig. 3). The most essential difference between *Echinus* and *Pentremites* is, that the latter is supported by a fixed column, and that all openings are found on the summit and formed by the apical system, whereas the main resemblance with the Crinoidea lies in the column, and, if you will, in the pinnulæ; whereas mouth, ovarian openings(?), ambulacral field, with its tentacles and general shape, reminds one more of Echinus or Astroidea than of Crinoidea or Cystoidea. Even the spines of the urchin are apparently not missing;—for I have a well preserved specimen of *Pentremites granulatus* Roemer = *Granatocrinus cidariformis* Troost, on which the coarse granules show very distinct sockets for the articulation of spines(?). Should further discoveries confirm this view, then this species might be removed from the genus *Pentremites* on account of its spines, but for the present it better remains with them.

Fig. 3.

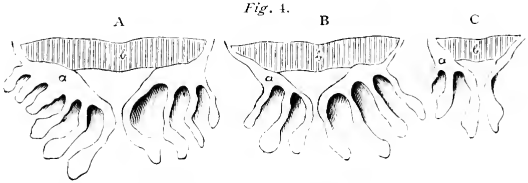
PENTREMITES SULCATUS, showing the development of the calyx: *a*, apical system; *b*, actinal system. The growth of the test is indicated by different shades.

Now, a few words about the proposed new classification of Mr. Carpenter. He says, "the basis of the classification which we have been led to adopt, is the morphology of the hydrospires and of their external openings, the so-called spiracles," etc.*

The general rule which governs the classification of our fossil Echinodermata, is the difference in the number and composition of pieces forming the exoskeleton. But, contrary to this rule, Mr. Carpenter considers the hydrospires as very characteristic and of much systematic value, although I believe he agrees with Billings in considering them respiratory organs. Admitting this view to be a correct one, and considering the difference in the form in which we find them preserved, we have to admit that they belong to the softer and interior organs; besides, they are so subject to abnormal developments (see Fig. 4) that it would be hard to say which was normal or which abnormal—a condition which has already been observed by Rofe; and for this, if for no other reason, we have to reject them as not possessing any characteristics of systematic value.

* Annals and Magazines of Natural History, April, 1882, p. 214.

Fig. 4.



TRANSVERSE SECTIONS OF AMBULACRAL FIELDS, to show abnormal developments of the hydrospiric sacs: A, of *Pentremitres pyroformis*; B, *P. forcalis*, C, *P. conoidens*—about 20 times magnified and drawn with the aid of the camera lucida. *a*, hydrospiric sac; *b*, calcareous part of ambulacral field, i.e. lancet and poral pieces.

Now, if we consider the second point, i.e. the external openings, the so-called spiracles, we will find that Mr. Carpenter is very inconsequent in his argument; for he says, "mere differences in the relative sizes of the calyx plates are of very little systematic value," etc. But, it seems, Mr. Carpenter forgets that the differences in the external openings are caused by the very differences in the relative sizes of the deltoid and lancet pieces; or does he mean to intimate that these pieces do not belong to the calyx plates?

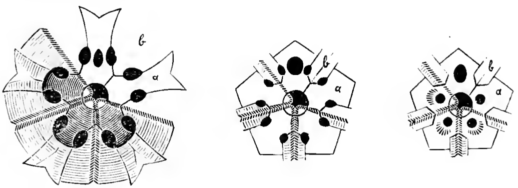
Still, if we suppose such a classification, according to the differences in the spiracle openings, was desirable and necessary, we could only (according to their external aspect and arrangement) divide them into three divisions, viz.: The first division would comprise all those species in which the horizontal portion of the deltoid piece is very narrow, the sinus to both sides in the deltoid and lancet pieces comparatively large, and so surrounded by the zigzag plicated integument that two of the so-formed openings appear externally only as one (see Fig. 5, A). This division would embrace such species as

Pentremites florealis Say,
" *sulcatus* Roemer,
" *pyriformis* Say,
" *Wortheni* Hall,
" *Reinwardtii* Troost,

and others.

The second division would comprise all those species in which the deltoid pieces are very broad, the lancet pieces very narrow, and the sinus for the formation of the spiracle openings in both deltoid and lancet pieces very little; the zigzag plicated integument corresponding to the narrow ambulacral field is not wide

Fig. 5.



Diagrams to show connections of deltoid pieces and ambulacral fields: By *a* and *b*, is the covering integument removed to show the sutures between (*a*) deltoid and (*b*) lancet pieces; A, *Pentremites sulcatus*: B, *P. melo*: C, *P. Norwoodi*.

enough, so as to surround these openings fully, hence they have to remain separate, or, in other words, where we have ten distinctly visible openings (see Fig. 5, B). This division would embrace species as

Pentremites melo Owen & Shumard,
" *Sayi* Shumard,
" *Roemeri* Shumard,
" *Burlingtonensis*, Meek & Worthen,
" *crenulatus* Roemer,

and others.

The third division would comprise all those species in which the deltoid pieces are perforated (see Fig. 5, C), because the lancet pieces do not reach far enough to the summit to enter into the composition of the spiracle openings. This division would embrace species as

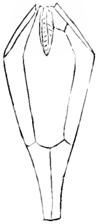
Pentremites Norwoodi Owen & Shumard,
" *Derbiensis* Sowerby,
" *ellipticus* Sowerby,

and others.

The circumstance of having the deltoid pieces perforated may make it desirable to separate this division from the genus *Pentremites*, but then the name *Granatocrinus* ought not to be chosen, as has been done by some of our American writers and now repeated by Mr. Carpenter, as it will confuse matters rather than make them more clear. The type specimen for which Dr. Troost proposed the generic name *Granatocrinus*, is *Granatocrinus cidariformis* Troost = *Pentremites granulatus* Roemer. But this species differs very materially from *P. Norwoodii* Owen & Shumard, as it possesses no perforated deltoid pieces (the chief characters for this genus according to Mr. Carpenter), besides other peculiarities in the ambulacral field. As we have seen, it is mainly the deltoid piece which causes the differences in the spiracle openings, and these pieces are subject to abnormal developments almost as much as the hydrospiric sac.* I see no good reason to separate the first division from the second, because the number and relative position of these plates to each other remains the same, and, as differences in the sizes of the calyx plates (as Mr. Carpenter remarks) are of no systematic value, they should not be separated.

All described *Pentremites* (except those which belong to the genus *Codaster* or *Codonites*) can easily be distributed in either one or the other of these three divisions; it is therefore impracticable to divide the genus *Pentremites* into four or five new genera, as has been proposed by Mr. Carpenter. For instance, the difference of *Troostocrinus clavatus*, according to Carpenter = *Pentremites clavatus* Hambach and *P. pyriformis* Say, consists mainly in the different length of the base and fork pieces, and there is certainly a closer relationship between these two species than between *P. clavatus* and *Reinwardtii* or *lineatus*. *P. Maia* and *Leda* Hall resemble more *Pentremites conoideus* Hall as *P. Curtus* and *Roemeri* Shumard or *angulatus* Phillips and *granulatus* Roemer. The difference between *Pentremites Pailleti*, *Reinwardtii*, *clavatus* Ham., *Wortheni*, *bipyramidalis*, *obliquatus*, and *Woodmani*, consists only in the different development of the calyx pieces and illustrates the transition from one species to another very well, but show no greater divergences than there exist between *Pentremites melo*, *Sayi*, *glaber*, *Roemeri*, *granulatus* Roemer, *neglectus*, etc.; or between *P. florealis*, *pyriformis*, *sulcatus*, *elongatus*, *hemisphericus*, *conoideus*, and *abbreviatus*. But neither one of these divisions possesses sufficient permanent characteristics to base a new classification on, nor would they be any improvement on the one given by

Fig. 6.



* To show the diversity in the development of the deltoid pieces, I give here (see Fig. 6) an outline figure of a *Pentremites Reinwardtii* which has on one side the deltoid piece laterally expanded. Besides this, I have a number of other anomalies in my collection, and Carpenter himself reports of one.

Roemer, which has been in use for some time, whereas the insufficiency of Shumard's will speak for itself; and, as long as we do not know of anything better, such a classification should be abandoned, as it would only increase our nomenclature with unnecessary synonyms. The mere recapitulation of what has been done by others is of very little value, even if a different terminology is used for it.

The condition of life was undoubtedly a similar one throughout the whole class, therefore it cannot very well be called an arbitrary assumption to suppose the presence of certain organs with the same physiological functions in all these animals. The absence or nondetection of either one of them is certainly due to an insufficient state of preservation; for the greatest number of specimens of those species is found in an imperfect state of preservation, but is no evidence that they were never in the possession of them.

The exoskeleton, i.e. the calcareous parts forming the calyx, as also the relative position of each, is the same in all *Pentremites* as well as in those recently separated from them (whether they are of a globose, truncate or clavate form, with small or broad ambulacral fields), and is certainly of far greater importance than the mere softer interior organs to which belong the hydrospiric sac and other vessels. The calcareous portion of the ambulacral field consists only of lancet pieces and poral pieces.

It is arbitrary and without any good reason to form of a certain number of species a new genus* because their base plates are small and depressed or elongated, or having a narrow, short or long sinus in the fork pieces, which, if such is the case, must necessarily give a different aspect to the individual, and cause them to be respectively either globose, elliptical, pyriform, or clavate, which forms are met with in both those having a broad or narrow ambulacral field. The number of hydrospiric plicas can hardly be of any consequence as shown above. Carpenter reports *Pentremites Reinwardtii* as having three plicas, whereas I have specimens which possess five, and others possessing a different number, in the same specimen.

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* See Carpenter, loc. cit.

Description of new Palæozoic Echinodermata.

By G. HAMBACH.

ECHINOIDEA.

PALÆCHINIDÆ McCoy.

Genus MELONITES Norwood and Owen.

Melonites crassus, n. s.

(Pl. C, Fig. 1.)

Body large, globose, like that of *Melonites multipora*, composed of very thick plates. Ambulacral areas running nearly equal in width and concave over the whole surface of the body, and almost two-thirds as wide as the interambulacrum, with a very high ridge in the centre, elevating its surface above that of the interambulacral field and dividing the same thus into two deep concave furrows. Plates composing the same are very irregular, wider than high, and numbering ten in a transverse row, of which the two middle ones, forming the ridge, are the largest and twice or more as wide as the others, each being laterally perforated by two pores, thus forming five double rows of pores to each side of the ridge. Surface granulated and covered with little spines of about $\frac{1}{8}$ of an inch in length. Interambulacral areas lanceolate in outline, moderately convex, but more so than in *Melonites multipora*, and nearly half as wide as the ambulacrum; composed of very large plates, of which the two lateral rows are pentagonal, all the others mostly hexagonal, irregular, wider than high, and as large as two and a half of the ambulacral ones; counting five in the greatest width of the field and gradually tapering off in number. Surface granulated and covered with little spines of $\frac{1}{16}$ of an inch in length; of these granules 45 to 68 may be counted on each of the larger interambulacral plates, according to size, and as many in proportion on the ambulacral ones. Oral opening and genital plates not visible in the specimen.

Making due allowance for the crushed condition of the specimen, I estimate the vertical height to be 3 or $3\frac{1}{4}$ inches; transverse diameter, about the same or a very little more; width of ambulacrum, $1\frac{1}{4}$ inch; width of interambulacrum, $\frac{7}{8}$ of an inch.

The species is readily distinguished from *Melonites multipora* in being throughout of a coarser structure; interambulacral areas composed of five rows of plates instead of from seven to nine; by having a more prominent ridge in the centre of the ambulacrum, and being also covered with larger spines. The number of interambulacral plates would alone be sufficient to separate it from *Melonites multipora*, as well as *Stewarti* Safford, which, after a careful examination of a good cast from the original specimen, I have to regard as synonymous with *multipora*—a conclusion arrived at after an examination of over 500 specimens, which proved that the number of plates in the interambulacrum is never less than seven or eight, whereas the one now described has only five in the greatest with of the field.

Geological formation and locality—In the lower St. Louis limestone, St. Louis, Missouri.

Melonites irregularis, n. s.

(Pl. C, Fig. 2.)

Body globose. Ambulacral field not quite so wide as the interambulacral space. Poral plates very small and irregular in size; there are from three to five rows to each side of the central ridge in the ambulacrum, which is very shallow. Interambulacral space composed of small hexagonal and pentagonal plates, less regularly arranged than in *Melonites multipora* and numbering from five to seven in the greatest width. Surface ornamented with coarse granulations, less numerous in the same space than in *multipora*. Genital plates the same as in other *Melonites*.

This species has the same general appearance as *Melonites multipora* with the exception of its smaller size, but is readily distinguished from the same by its smaller plates, both ambulacral and interambulacral, which are less in number and not so regularly arranged. The general size of the body varies from $1\frac{2}{3}$ to $2\frac{1}{2}$ inches and its transverse diameter is $\frac{1}{8}$ larger than the vertical one.

Geological formation and locality — In the upper St. Louis limestone, St. Louis, Missouri.

Genus OLIGOPORUS Meek and Worthen.

Oligoporus parvus, n. s.

(Pl. C, Fig. 3)

From this species I possess only crushed, or rather imperfect specimens, like all others I have seen; however, some parts are sufficiently preserved so as to allow a correct idea of the form of the body, which was undoubtedly similar to the others of the same genus. The ambulacra are narrow, running over the whole surface of the body, and are composed of four rows of poral plates, very irregular in size as well as form, of which the larger ones form in the centre of the field quite an elevated ridge, with here and there an odd plate inserted between the regular rows; each plate is perforated by two pores near the outer margin of the plate, thus forming two double rows of pores to each side of the ridge. Interambulacral space nearly one-third wider than the ambulacral, and composed of hexagonal and pentagonal plates very coarsely granulated and covered with very short spines; the number of plates is not over five in the greatest width of the field. Oral and genital plates not visible.

Geological formation and locality — In the lower St. Louis limestone, St. Louis, Missouri. Specimen in the collection of the Washington University.

Making due allowance for the crushed condition in which I have found all the specimens I have seen, I think that the following measurement will give as near as possible the actual size of the body: transverse diameter, about 2 inches; vertical height, about $1\frac{3}{4}$ inches.

Genus Archæocidaris McCoy.

Archæocidaris Newberryi, n. s.

(Pl. D, Fig. 1)

All the specimens I have seen and possess are so much distorted as to make it impossible to give an accurate description of the general shape of the body, though I believe it to be like other *Cidaridæ*.

Plates of the interambulacral space large hexagonal and pentagonal where they join the ambulacrum ; central tubercle papilliform with a double annulation at the summit, of which the outer one is the largest surrounding the crateriform tubercle in the centre ; margin of plates elevated and ornamented by a row of granulation. Ambulacral plates very small, elongated, nearly three times as long as wide, and perforated by two pores. Spines elongated, slightly compressed in the upper part, lower portion round, a little contracted and bent above the crenulated annulation of the articulation extremity ; surface very finely striated and ornamented with small ascending spines. Their greatest diameter is about one-third the length above the base. Length of primary spines of a large specimen 2½ inches,' tapering down to almost ½ an inch ; length of spines covering the margin granulations, about ⅛ of an inch.

This species differs from *Archæocidaris Shumardi* Hall, in the more robust form of its plates and spines, which are very finely dotted in the two upper thirds of the spine in *Shumardi*,* as well as in the double annulation of the central tubercle.

Geological formation and locality — In the lower St. Louis limestone, St. Louis, Missouri. Specimen in the collection of the Washington University. Named in honor of Prof. I. S. Newberry, of Columbia College, New York.

BLASTOIDEA.

Genus Pentremites Say, n. s.

Pentremites Sampsoni, n. s.

(Pl. D, Fig. 2, 2*a*.)

* See I. Hall's Geological Survey of Iowa, vol. i., pt. ii., pl. 26, fig. 3.

Body ovoid, having its greatest diameter a little above the centre of the calyx. Pelvis very small, not depressed; its diameter is equal to about three times the thickness of the column; externally ornamented with granules running parallel to the sutures. Fork-pieces long; sinus for the reception of the ambulacral field as long as four-fifths of its entire length, being wider in the beginning than towards the apex, with a little crest in the centre of its base portion. Deltoid pieces small, lateral expansion as long as one-fifth of the entire body, externally ornamented with large and small granules arranged in a rosette shape, and a flat raised triangular surface near the mouth. Ambulacral field extending nearly over the entire surface of the body, with a comparatively deep groove in the centre, being wider in the beginning than toward the apex. Lancet pieces half as wide as the sinus. Poral pieces comparatively small, numbering nine in one-tenth of an inch. Mouth central; ovo-spiracle apertures very small, each isolated, except two which adjoin the anal opening, being situated at the beginning of the flat triangular surface. Interambulacral space ornamented by alternating broad and small transverse plications running almost horizontally along the margin of the ambulacral field, leaving in the centre a lancet-shaped depression which is ornamented with fine longitudinal granulated lines.

Dimensions—Vertical height about one-fifth more than the greatest transverse diameter.

Geological formation and locality — In the Chouteau limestone in Pettis Co., Missouri.

I dedicate this fine species to the lucky finder, my friend, Mr. F. A. Sampson, of Sedalia, Missouri. The specimen is in his collection.

For better comparison and to show the difference between it and allied species, I have given also the figures of the original specimens of *Pentremites Rœmeri* Shumard (pl. D, figs. 3, 3*a*) and *Pentremites granulosus* Meek and Worthen (pl. D, figs. 4, 4*a*), of which the original specimen was kindly loaned to me by Prof. A. H. Worthen.

Pentremites gemmiformis, n. s.

(Pl. D, Fig. 5.)

Body gemmiform. Pelvis cylindrical, except the upper margin, which is bent a little outwards; its length amounts to fully one-third of the entire length of the calyx, whereas its transverse diameter is a little less than half of the greatest transverse diameter. Fork-pieces nearly twice as long as wide; its base portion occupies not quite one-half of the piece, sloping from the centre gently sidewards and downwards, so that the lower part of the body is rather a little longer than the upper one; sinus for the reception of the ambulacral field broad. Deltoid pieces small, arrow-head shape, twice as long as wide, and do not reach up to the summit. Ambulacral field broad, slightly convex, and sunk a little into the sinus, so that they are surrounded by a fine elevated crest of the fork-piece, which becomes more prominent near the base of the field, but less towards the apex. Lancet pieces half as wide as the field. Poral pieces comparatively large, counting eight to one-tenth of an inch. All apertures on the summit rather large, but closely arranged. Surface apparently ornamented with very fine striæ running parallel to the sutures. Interambulacral space flat and not depressed.

Geological formation and locality — In the Kaskaskia limestone, Randolph county, Illinois. Rare. The specimen is in the collection of the Washington University.

This species resembles somewhat *Pentremites calycinus* Lyons, but is easily distinguished by its more robust base portion, by having no constriction around the same near the articulation surface of the column, by the larger poral pieces, and the less transverse diameter.

To show better the difference between *Pentremites gemmiformis* and *calycinus*, I have also given on Pl. D two figures of the last named one in Figs. 6 and 7.

Genus Codonites Meek and Worthen.

Codonites campanulatus, n. s.

(Pl. D, Figs. 8, 9.)

Body bell-shaped. Base portion composed of three pieces as in the true *Pentremites*, cup-shaped, its upper diameter about three times as large as the articulation surface of the column with a slight constriction in the middle, thus giving to the lower part a more stem-like appearance. Fork-pieces elongated; their base portion occupies two-thirds of the entire length and slopes from the apex of the ambulacrum gently downwards, but more abruptly to both sides, giving thus a depressed appearance to the interambulacral space. Deltoid pieces short. Ambulacral fields narrow lancet-shaped, with the greatest transverse diameter near the junction of the deltoid and fork-pieces. Lancet pieces nearly as wide as the sinus, and sloping from the median line to the margin of the ambulacrum, thus forming on both sides of the margin a kind of triangular groove which is filled out by the poral pieces. Poral pieces small, numbering nine to one-tenth of an inch. All openings on the summit like those of *Codonites stelliformis*, i.e. one longitudinal slit to both sides of the ambulacral field for the ovo-spiracle openings and a large round one laterally. Surface apparently smooth and not ornamented.

Dimensions — Greatest diameter at the apex of the ambulacral field, five-sixths of the entire length of the calyx; vertical height from articulation surface of column to apex of ambulacral field, two-thirds of the entire height.

Geological formation and locality—In the lower Burlington limestone at Sedalia, Mo. The specimen is in the collection of Mr. F. A. Sampson, of Sedalia.

For better comparison and to show the difference between it and *Codonites stelliformis*, I have also given the figure of a medium size specimen of the *stelliformis* (pl. D, fig. 10) from Burlington, Iowa.

EXPLANATION OF PLATE *C.*

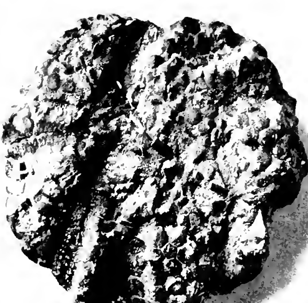
Fig. 1. *Melonites crassus.*
Fig. 2. *Melonites irregularis.*
Fig. 3. *Oligoporus parvus.*

EXPLANATION OF PLATE *D.*

Fig. 1. *Archæocidaris Newberryi.*
Fig. 2. *Pentremites Sampsoni*, natural size.
2*a*. The same enlarged.
Fig. 3. *Pentremites Rœmeri*, Shumard, natural size.
3*a*. The same en arged. From the original of the Shumard collection now in Washington University.
Fig. 4. *Pentremites granulosus*, Meek and Worthen, natural size.
4*a*. The same enlarged. From the original in the collection of Prof. A. H. Worthen.
Fig. 5. *Pentremites gemmiformis.*
Figs. 6 & 7. *Pentremites calycinus*, Lyons.
Figs. 8 & 9. *Codonites campanulatus.*
Fig. 10. *Codonites stelliformis*, Owen and Shumard.

Pl. C.

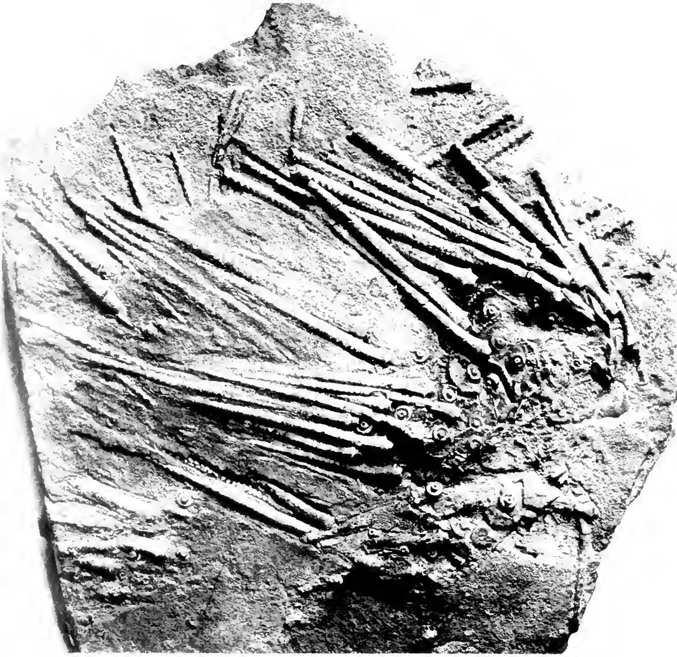
1.



3.

2.

Pl. D

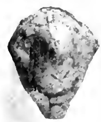


1.

2. 3. 4.

2a. 3a. 4a.

6. 5. 7.



8. 9. 10.

EXPLANATION OF PLATE 1.

Fig. 1. PHYLLOGRAPTUS(?) DUBIUS (Spencer), p. 15.

Fig. 2. RETIOLITES VENOSUS (Hall), p. 16.

Fig. 3. DENDROGRAPTUS RAMOSUS (Spencer), p. 17.

3*a*. Branch enlarged.

Fig. 4. DENDROGRAPTUS SIMPLEX (Spencer), p. 17.

Fig. 5. DENDROGRAPTUS DAWSONI (Spencer), p. 18.

5*a*. Branch enlarged.

Fig. 6. DENDROGRAPTUS FRONDOSUS (Spencer), p. 18.

6*a*. Branch enlarged.

Fig. 7. DENDROGRAPTUS PRÆGRACILIS (Spencer), p. 19.

Fig. 8. DENDROGRAPTUS SPINOSUS (Spencer), p. 19.

Fig. 9. CALLOGRAPTUS NIAGARENSIS (Spencer), p. 21.

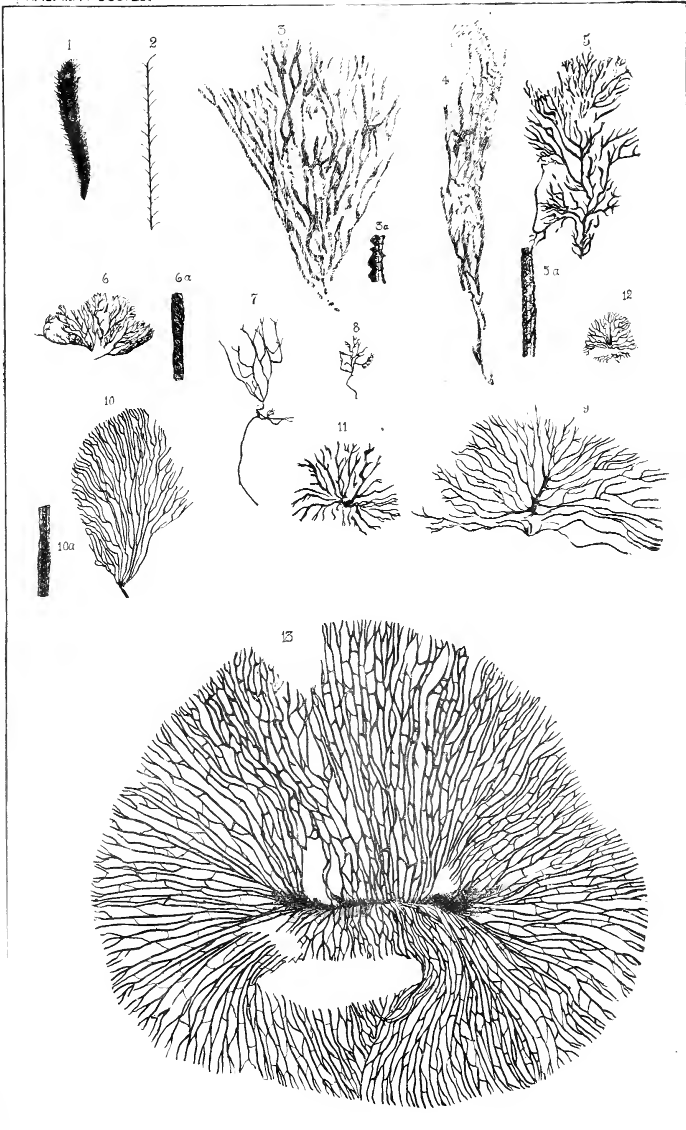
Fig. 10. CALLOGRAPTUS GRANTI (Spencer), p. 21.

10*a*. Branch enlarged.

Fig. 11. CALLOGRAPTUS MULTICAULIS (Spencer), p. 22.

Fig. 12. CALLOGRAPTUS MINUTUS (Spencer), 22.

Fig. 13. DICTYONEMA TENELLUM (Spencer), 26.


1
2
3
3a
4
5
5a
6
6a
7
8
12
10
10a
11
9
13

EXPLANATION OF PLATE 2.

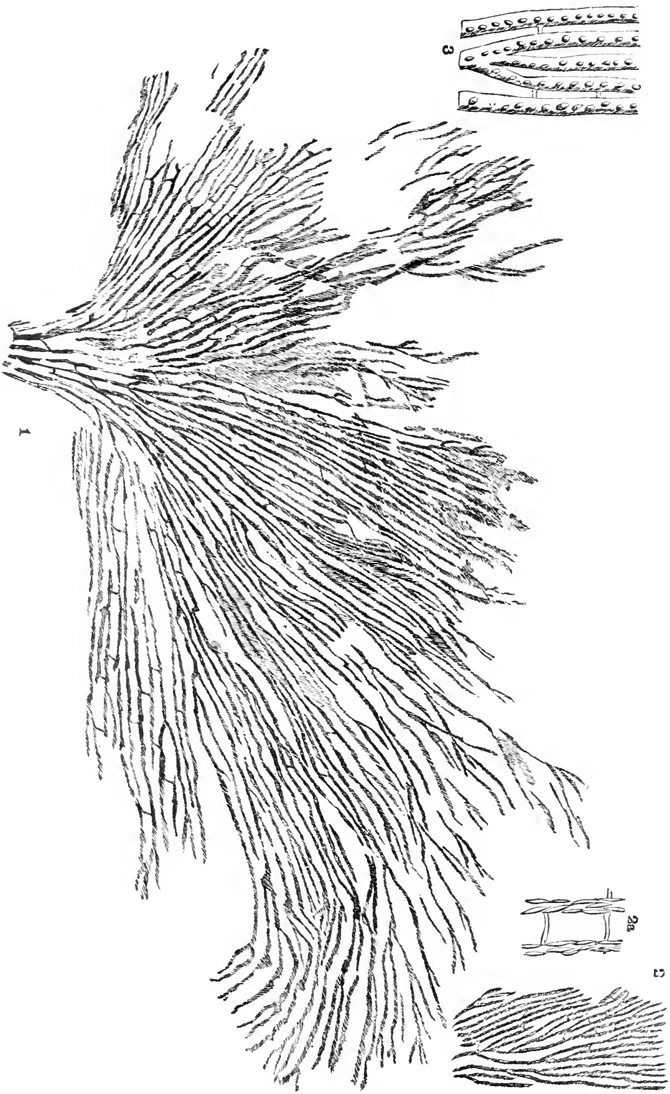
Fig. 1. DICTYONEMA EXPANSUM (Spencer), p. 25.

Fig. 2. DICTYONEMA GRACILE (Hall), p. 24. Only a small portion of the frond is represented.

2*a*. Branch of same enlarged, p. 24.

Fig. 3. DICTYONEMA GRACILE (Hall), p. 24. A celluliferous portion of frond found at Hamilton, Ont.

NIAGARA FOSSILS. PLATE 2.



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EXPLANATION OF PLATE 3.

Fig. 1. Dictyonema retiforme (Hall), p. 23.

1*a*. Branch enlarged.

Fig. 2. Young frond of same species.

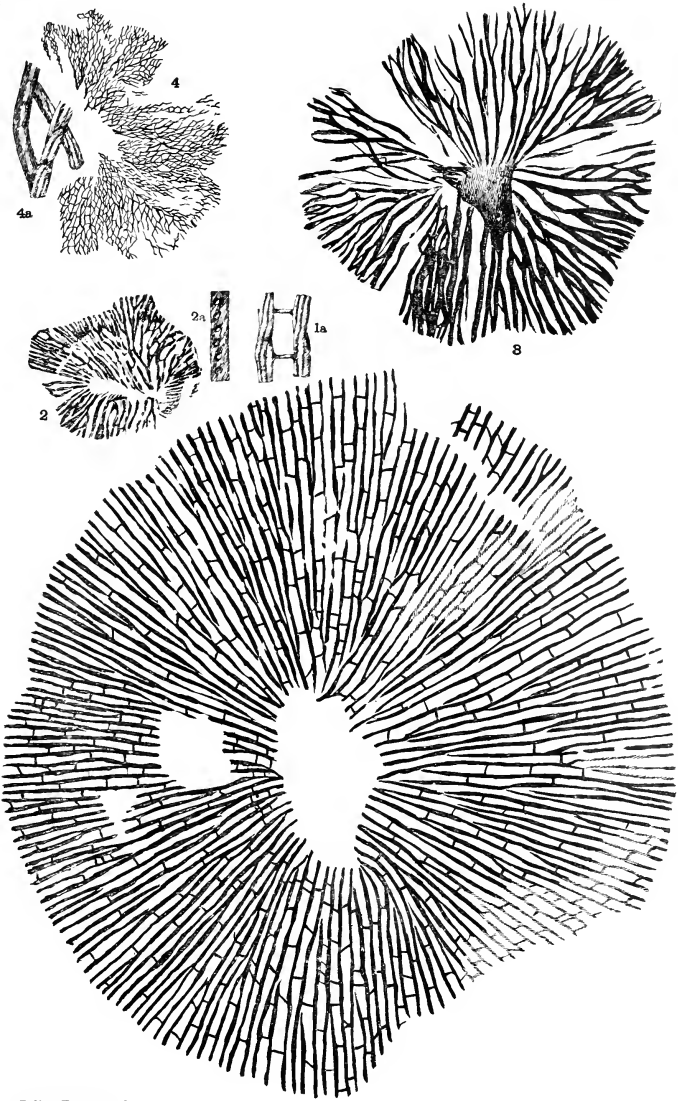
2*a*. Branch enlarged,

Fig. 3. Calyptograptus cyathiformis (Spencer), p. 28.

Fig. 4. Calyptograptus micronematodes (Spencer), p. 29.

4*a*. Branch enlarged.

NIAGARA FOSSILS. PLATE 3.



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EXPLANATION OF PLATE 4.

Fig. 1. CALYPTOGRAPTUS SUBRETIFORMIS (Spencer), p. 28.

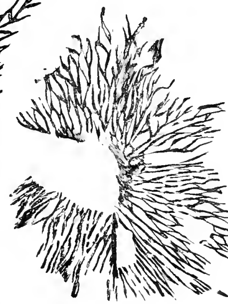
2. Circular frond of same.

Fig. 3. CALYPTOGRAPTUS(?) RADIATUS (Spencer), p. 30.

Fig. 4. RHIZOGRAPTUS BULBOSUS (Spencer), p. 30.

Fig. 5. ACANTHOGRAPTUS GRANTI (Spencer), p. 31.

Fig. 6. ACANTHOGRAPTUS PULCHER (Spencer), p. 32.



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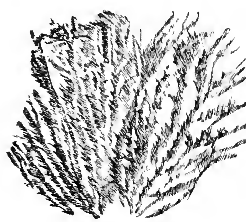

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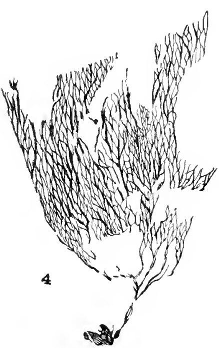

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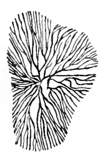

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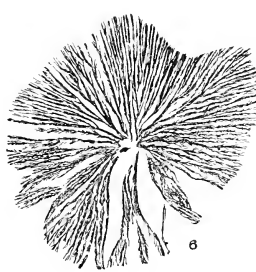

6

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EXPLANATION OF PLATE 5.

Fig. 1. INOCAULIS PLUMULOSUS (Hall), as occurring at Hamilton, Ont., p. 34.

Fig. 2. INOCAULIS WALKERI (Spencer), p. 35.

Fig. 3. INOCAULIS PROBLEMATICUS (Spencer), p. 36.

Fig. 4. INOCAULIS DIFFUSUS (Spencer), p. 36.

Fig. 5. INOCAULIS CERVICORNIS (Spencer), p. 37.

Fig. 6. INOCAULIS PHYCOIDES (Spencer), p. 38.

Fig. 7. Branch of another specimen.

7a. Same enlarged.

NIAGARA FOSSILS PLATE 5.

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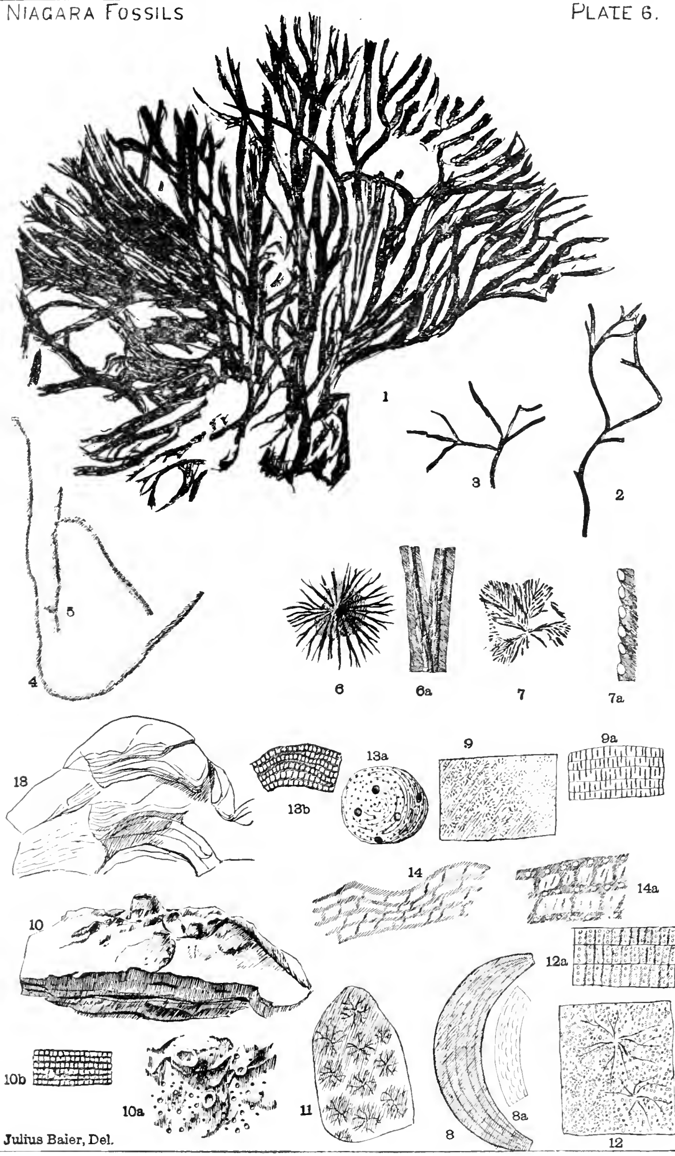
EXPLANATION OF PLATE 6.

Fig. 1. INOCAULIS RAMULOSUS (Spencer), p. 38.
Fig. 2. THAMNOGRAPTUS(?) MULTIFORMIS (Spencer), p. 40.
Fig. 3. Another specimen of same.
Fig. 4. THAMNOGRAPTUS BARTONENSIS (Spencer), p. 39.
Fig. 5 Another specimen of same.
Fig. 6 CYCLOGRAPTUS ROTADENTATUS (Spencer), p. 42.
6*a*. Branch magnified.
Fig. 7. PTYLOGRAPTUS FOLIACEUS (Spencer), 41.
7*a*. Branch of same magnified.
Fig. 8. STROMATOPORA CONCENTRICA (Goldfuss), p. 45. Transverse section, slightly enlarged.
8*a*. The same further enlarged.
Fig. 9. CAUNOPORA WALKERI (Spencer), p. 46. Horizontal section, enlarged (×2).
9*a*. Vertical section, enlarged.
Fig. 10. CAUNOPORA MIRABILIS (Spencer), p. 47. Natural size.
10*a*. View of fragment of surface, natural size
10*b*. Vertical section, enlarged.
Fig. 11. CŒNOSTOMA CONSTELLATUM (Hall), p. 48. Horizontal section, natural size.
Fig. 12. CŒNOSTOMA RISTIGOUCHENSE (Spencer), p. 49. Horizontal section, natural size.
12*a*. Vertical section, enlarged.
Fig. 13. CŒNOSTOMA BOTRYOIDEUM (Spencer), p. 50.
13*a*. Horizontal section, slightly enlarged.
13*b*. Vertical section, enlarged.
Fig. 14. DICTYOSTOMA RETICULATUM (Spencer), p. 51. Vertical section, enlarged (×1.5).
14*a* Vertical section, enlarged (×3).

NIAGARA FOSSILS

PLATE 6.



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EXPLANATION OF PLATE 7.

Fig. 1. PALÆASTER GRANTI (Spencer), p. 53. Natural size.

Fig. 2. FENESTELLA BICORNIS (Spencer), p. 55

2a. Magnified, showing relative sizes of branches and interspaces.

Fig. 3. RHINOPORA VENOSA (Spencer), p. 54.

Fig. 4. CLATHROPORA(?) GRACILIS (Spencer), p. 54.

Fig. 5. POLYPORA (FENESTELLA) ALBIONENSIS (Spencer), p. 55.

5a. Fragment, magnified, showing the spaces betwe n the branches.

Fig. 6. PLEUROTOMARIA CLIPEIFORMIS (Spencer), p. 57. Surface view.

6a. Side view of same.

Fig. 7. ORTHOCERAS BARTONENSE, p. 60.

Fig. 8. CYRTOCERAS REVERSUM, 60.

Fig. 9. LITUITES NIAGARENSIS, 60.

EXPLANATION OF PLATE 7.

Fig. 1. PALÆASTER GRANTI (Spencer), p. 53. Natural size.

Fig. 2. FENESTELLA BICORNIS (Spencer), p. 55

2*a*. Magnified, showing relative sizes of branches and interspaces.

Fig. 3. RHINOPORA VENOSA (Spencer), p. 54.

Fig. 4. CLATHROPORA(?) GRACILIS (Spencer), p. 54.

Fig. 5. POLYPORA (FENESTELLA) ALBIONENSIS (Spencer), p. 55.

5*a*. Fragment, magnified, showing the spaces betwe n the branches.

Fig. 6. PLEUROTOMARIA CLIPEIFORMIS (Spencer), p. 57. Surface view.

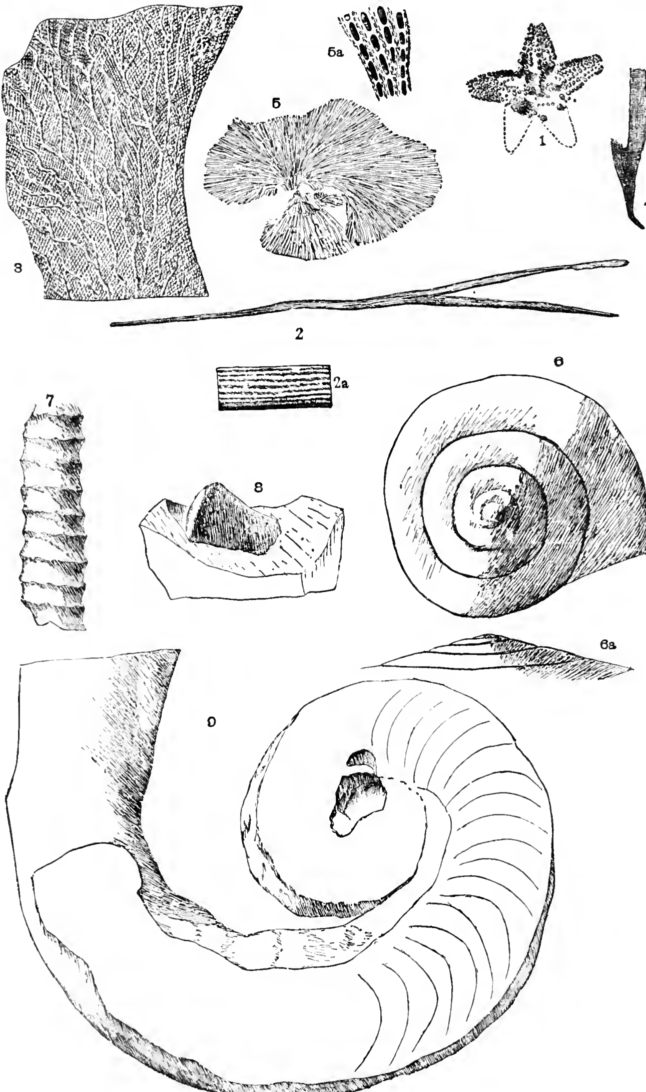
6*a*. Side view of same.

Fig. 7. ORTHOCERAS BARTONENSE, p. 60.

Fig. 8. CYRTOCERAS REVERSUM, 60.

Fig. 9. LITUITES NIAGARENSIS, 60.

NIAGARA FOSSILS PLATE 7



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EXPLANATION OF PLATES 8 & 9.

Fig. 1. CONULARIA MAGNIFICA (Spencer), p. 58. Natural size.
1*a* & 1*b*. Surfaces enlarged.

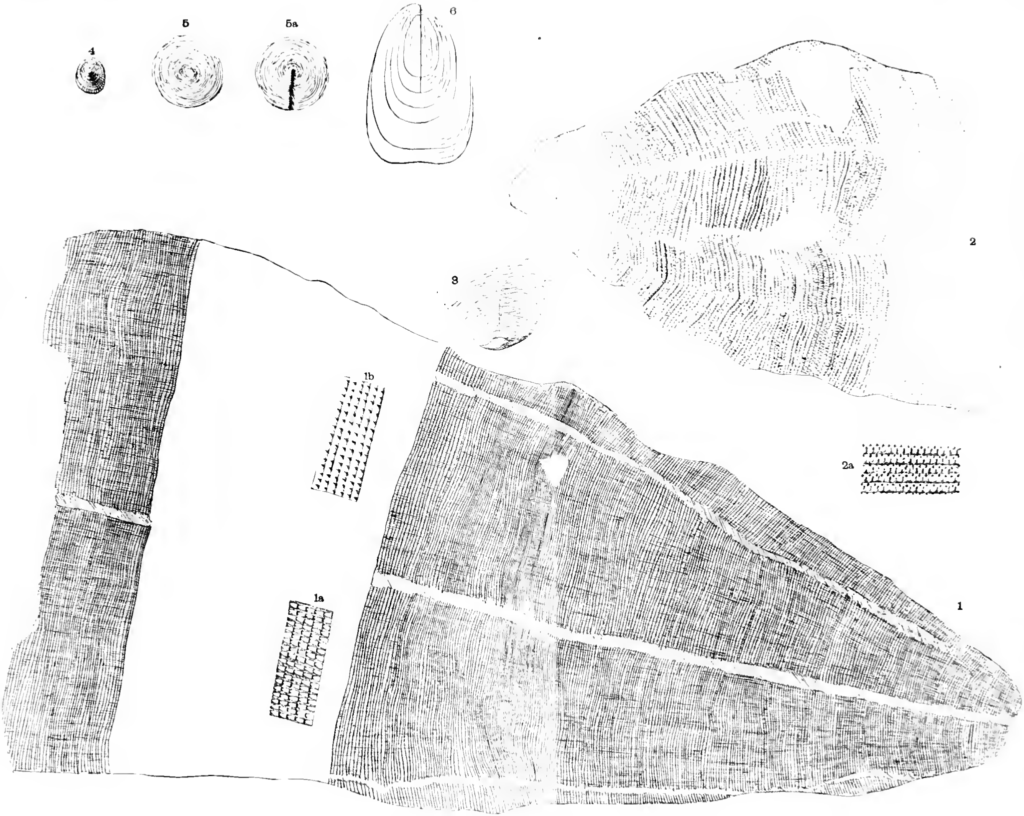
Fig. 2. CONULARIA RUGOSA (Spencer), p. 59.
2*a*. Inner surface, enlarged.

Fig. 3. CONULARIA WILKINSI, p. 59.

Fig. 4. CRANIA ANNA, p. 57.

Fig. 5. DISCINA CLARA, p. 56. Dorsal valve.
5*a*. Ventral valve.

Fig. 6. LINGULA INGENS, p. 56.



Julius Baier, Del.

Niagara Fossils.

By J. W. SPENCER, B.A.Sc., A.M., Ph.D., F.G.S.

Professor of Geology in the University of the State of Missouri; late Vice-President of King's College of Nova Scotia.

PART I.

GRAPTOLITIDÆ OF THE UPPER SILURIAN SYSTEM.

PART II.

STROMATOPORIDÆ OF THE UPPER SILURIAN SYSTEM.

PART III.

FIFTEEN NEW SPECIES OF NIAGARA FOSSILS.

NINE PLATES.

PART I.

GRAPTOLITIDÆ OF THE UPPER SILURIAN SYSTEM.

INTRODUCTION.

The plant-like animal forms which have been included in the Graptolite family have hitherto been considered as belonging essentially to the muddy deposits of the Cambrian and Cambro-Silurian systems. However, a Canadian locality was discovered at Hamilton, Ontario, in the Niagara series, about the year 1868, by Lieut.-Col. Charles Coote Grant (H. P. 16th Reg't H.B.M. service). The earliest Upper Silurian Graptolites made known were five species, described by Prof. James Hall, Pal. of N. Y., vol ii., 1852. Since that time six more species have been added by Dawson, Billings, Hall, and Whitfield. During 1878, the writer described nine additional species in the Canadian Naturalist In the present paper there will be found twenty-one new species, and the plates of the previously described nine species (figured for the first time); thus making forty-one described species of Upper Silurian Graptolites.

For a large number of the specimens, herein described, I am indebted to the generosity of the indefatigable worker Col. Grant. Other acknowledgments are due to Mr. A. E. Walker, and to Mr. Turnbull, of Hamilton, Ontario.

Occurrence of Graptolites.

The Graptolites are almost entirely derived from the quarries at or near the "Jolly-cut road," south of Hamilton. As few fossils of the Niagara group in Ontario can be said to be abundant. so the Graptolites are scarce; yet it will be seen that the varieties are numerous. The beds in which they are principally found are those about six feet above the base of the "chert beds," and in the more shaly dolomites immediately underlying. In these last rocks the specimens are in a better state of preservation, especially at their earthy partings, though easily obliterated.

The only fossils of this family, that I have seen in the Clinton beds, are obscure or poorly preserved specimens of the genus *Dictyonema.*

In the following descriptions I have often been compelled to depend almost entirely upon the size of the stipes and the mode of branching, as the cellular structure has been obliterated in the majority of cases, even when the general form of the frond is perfectly distinct. This arises from the fact that the greatest varieties of species occur in the cherty dolomites, where, although the carbonaceous matter remains, the semi-crystallization of the dolomitic earth has obliterated the internal structure.

It sometimes happens that where the carbonaceous matter is removed the impressions of the cellular orifices are retained on the surfaces of the stone. Again, where extremities of the branches are broken off and the cellular arrangements are obscure, it is impossible to do anything with the fragments; and no doubt there are many undescribed species yet remaining in the group of fossils at Hamilton.

The material from which I worked out more than thirty species consisted of between three and four hundred specimens belonging to my own collection, and supplemented by those of McGill University and the Canadian Geological Survey. The amount of work in classifying them was very great, as there is a considerable variation in the forms, producing an inclination to make too many species. As much time, as my professional duties would permit, has been devoted to the subject, yet the work must be regarded as incomplete. In 1878 a notice of a few species of Graptolites was published in the Canadian Naturalist for that year. Even of the species there described much better material has since been obtained, and a revision is here included.

Literature of the History of the Study of the Graptolite Family.

The literature of the study of the Graptolites is widely diffused both as to place and time. In 1850, Barrande reviewed the geographical and geological distribution of the Family as then known. In the Canadian Organic Remains, decade ii., and subsequently in the twentieth Report of the Museum of Natural History of the University of New York, Prof. Hall has given the bibliography of the Family. In 1867, Mr. Caruthers published "*Graptolites: their structure and systematic position.*" Still more recently, Prof. Nicholson, following Hall, published a paper on the study of the *British Graptolites*, in which he gives a list of the published papers. But Prof. Hall's monographs of what is known are sufficient for the American student, unless he wishes to consult the original papers both in Europe and America.

In turning to the History of the subject we find that Linnæus, in the first edition of *Systema Naturæ*, in 1736, founded the genus *Graptolithus* or *Graptolites*. His type was *G. scalaris*. But Barrande considers *G. sagittarius* (Linnæus) as the true type of the genus. In 1821 and 1822, Wahlenberg and Schlotheim regarded these fossils as slender Orthoceratites. In 1828, Brongniart obtained specimens from the Quebec Group at Point Lévis, the great home of the family, and described them as Fucoides. Prof. Nillson appears to have been the first to have recognized the *Graptolites* as polyps, in which opinion he was followed by Brown, Hisinger, and others. Again, Quenstedt and Geinitz regarded them as Cephalapods. This brings us down to 1843, when Vanuxem recognized Brongniart's *Fucoides dentatus* in the Utica slate. In 1843, Gen. Portlock recognized them as Zoöphytes, and pointed out their analogy with *Sertularia* and *Plumularia*, and suggested the idea of several genera or even orders being included in the genus. By 1850 the species known became greatly increased, and they were recognized as characterizing different horizons by Mather, Emmons, Hall, Murchison, De Verneuil, Sedgwick, Salter, Phillips, and others. Some of these geologists considered them as polyps, others as plants, while others did not commit themselves. In 1850 a considerable number of new species were added to the list by Barrande, who placed them among polyps. In the same year McCoy described the first form with a double row of cells. In 1852, Geinitz changed his view and placed them amongst Zoöphytes, and proposed several new generic names. Since that date many new species have been added to the list, mostly by the geologists above referred to. The two greatest additions to our knowledge of this fauna in America have been made by Prof. Hall in the descriptions of a large number of species from the Utica and Hudson Groups, and still more recently from the Quebec Group of Canada. (See Prof. Hall's 20th Report N. Y. State Museum of N. N.)

Geological Distribution.

From Prof. Hall's list of Graptolites we find one species in the Potsdam; fifty-three species (belonging to twelve genera) in the Quebec Group (Upper Cambrian); four species in the Trenton; thirty species, of eight genera, in the Utica and Hudson River Group (Cambro-Silurian); two species in the Clinton; three species in the Niagara; one species in the Corniferous, and two species in the Hamilton formations. To this list there have subsequently been added two species, and four of Dawsonia (supposed to be graptolitic ovarian sacs) in the Quebec group; one in the Trenton, and six in the Niagara formation.

In 1878, in a paper in Canadian Naturalist, I added three new genera and nine additional species as occurring in the Niagara formation at Hamilton, Ontario. In the present paper, including those formerly described by myself, I add to the list of American Graptolites four additional genera and thirty new species, making in all forty-one known species of twelve genera belonging to the Upper Silurian formations.

From this analysis of the geological distribution, we easily see the great antiquity of this type of organisms, and the very important addition that has been discovered, not only of the variety of forms, but also in a horizon so high.

Of those formerly known, with the exception of the few species in Trenton limestone and a few more in somewhat harder Hudson River calcareous shales, almost the whole fauna is confined to shaly beds. Those obtained at Hamilton, in the Niagara formation, are mostly in dolomitic limestones, or at most in only slightly shaly limestones.

Zoölogical Affinities.

It is easily seen how difficult it was originally to recognize the true character of the Graptolites. The majority of specimens is represented on the stone by only carbonaceous matter, fragmentary and structureless. It was only after examining scores of specimens that one could observe such structure as has been described in the following species, belonging to the Niagara formation. Equally great has the difficulty been found in recognizing many species of the Canadian Utica shale. Even the corneous structure was often not unquestionably shown, though in the limestones it is sometimes better preserved than in the shales. But the idea of their plant-origin has long since been abandoned. The solid axis and the more or less jointed appearance arising from crushed cells may have led to the early idea that the short fragments were Orthoceratites. As before stated, Prof. Nillson was the first to place them amongst polyps, and Gen. Portlock the first to class them amongst the *Hydrozoa* with *Sertularia*, in which relation they are now generally regarded, as has been maintained by Prof. Hall. Even if the analogy of some of the forms described be not very close to the modern *Sertularia*, it could scarcely be wondered at, as they all belong to only the more ancient forms of life, without representatives, even in type, reaching through the long geological blank. That the Niagara forms are of animal origin is clearly shown, not only on account of the corneous substance seen in all the species, but on account of the apparent solid axis often seen, and the cellular structure sometimes seen. Even in those species where the cellules are not recognizable, the analogy to other specimens, when they are apparent, is sufficiently close to leave no doubt. That the *Graptolites* belong to some form of polyps, as we have stated, is generally admitted. But some would place our Niagara *Dictyonema* and allied forms along or near to Fenestella on account of some resemblance in the mode of growth, but where the structure is preserved I have failed to draw the analogy.

The Structure of the Graptolites.

The divisions proposed by Prof. Hall I have followed. First, we have the radicle or initial point; second, "the funicle or non-celluliferous connecting portions of the compound fronds, and the barren portion of the stipes"; third, the central disc. In the parts of the stipe we have: 1, solid axis; 2, common canal or cœnosarc; 3, calycles or cellules (*hydrotheca*); 4, nature and ornaments of tests.

Some of the Graptolites of the older formations are considered as not having been attached. This may possibly have been the case with some of our cyathiform species in the Niagara, but the evidence is that they were mostly attached by a common root. In one case, all the branches arise from a slender stalk, at the base of which there is a conspicuous, large bulbous root; in another, the central disc appears to have been attached either directly to a stone or by fibres in the mud. Wherever the radicle is preserved it is non-celluliferous, and where not preserved the frond appears to have been broken off. Only in one species have we a distinct central disc. In those species where the cellules are on one side of the disc, the solid strengthening axis is lateral; in other cases, where the solid axis is central, the cellules are in two or more rows on the surface. A common canal extends the whole length of the stipes on one side of, or around, the solid axis, and in this the walls of cellules extend to the axis. The cellules are often only represented by serratures along the sides of the specimens, or as oval pits on the surfaces. The surfaces are generally striated. But here the depressions are often caused by the crushed polipary covering the position occupied by the late individual polypi

Reproduction of the Graptolites.

From the specimens which have been obtained in the Niagara formation in Canada, I have not been able to recognize the mode of reproduction. In 1858, Prof. Hall observed a few graptolitic stipes bearing what he regarded as reproductive cells. Of these, he says, that they appear first as ovate buds upon the margins, extending beyond the ordinary cellules, and enlarging to elongated sacs, swollen at extremities, becoming dehiscent, and discharging the ovules. There is very little substance except along the margin, where a filiform extension appears to represent the solid axis; numerous fibres also traverse the sacs, and remain attached to the original stipes of the parent. This mode of reproduction as Prof. Hall points out is strong evidence of their Hydroid character, having the nearest analogy to Sertulariana. In the Niagara formations we often find small specimens consisting of a radicle and a few branches. That these are young specimens is apparent. But as the structure is not recognizable, and the branching too rudimentary, it is impossible to determine their place. In *D. retiformis*, and some other species where we find very great variations in size, the smaller specimens have their structure and parts as fnlly developed as in the larger, and the growth appears to have been only the lengthening of the polyparies, without the lower poitions becoming any stronger.

Classification of the Graptolites.

The resemblance of the Niagara Graptolites to the more complex forms of the Quebec group is very striking. Our species of *Dictyonema* are not distantly related. Especially are the forms of *Dendrograptus* and *Callograptus* closely allied to those of the older group. Again, *Cyclograptus* is here the solitary representative of the discoid types of the Cambrian period, and much more beautiful. Some new forms appear, but these are nearly allied to the older genera.

In the classification of the Graptolites I have followed Prof. Hall, which is here given, together with those newly discovered forms belonging to the Niagara group.

Synopsis of the Genera of Graptolitidæ.

I.

"Species consisting of stipes or fronds, with a bilateral arrangement of parts; a solid axis, with a common canal extending along each series of cellules."

1. "The successive buds developed in tubular cellules, which are usually in contact for a greater or less proportion of their length."
   - (*a*) Cellules on one side of solid axis. } Graptolithus (with its sub-genera) and Cœnograptus.
   - (*b*) Cellules on two sides of axis. } Diplograptus.
   - (*c*) Cellules on four sides of common axis. } Phyllograptus.
2. "Cell-apertures excavated in margins of the stipes, without tubular extension or calycle; margins of cellules plain or ornamented."
   - (*a*) "Cell-apertures on two sides of sublinear stipe." } Climacograptus.

(*b*) "Cellules on two sides near base, stipes dichotomous above, with a row of cells only on the outer margins of each division." } Dicanograptus.

3. "Solid axis eccentric or sub-exterior, with cellules developed in parallel ranges on opposite sides of the stipe, and in contact throughout their entire length."

(*a*) "Known only as separate stipes with reticulate test." } Retiolites.

(*b*) "Occurring as simple stipes and compound fronds; test smooth." } Retiograptus.

II.

"Species having a common trunk or stem, or growing in sessile groups of stipes, from a common origin, without distinct bilateral arrangements of the parts."

1. Cellules in a single series on one side of the stipe or branches, and situated along one side of common canal.

(*a*) "Branching free (not connected by transverse bars); cellules in contact or closely arranged." } Dendrograptus.

(*b*) "Branches infrequently connected by transverse bars." } Callograptus.

(*c*) "Stipes and branches more or less regularly united in a reticulate frond, without elongate stem." } Dictyonema.

(*d*) Stipes and branches touching or overlapping in a reticulated manner, but without or with very few transverse bars. (Spencer.) } Calyptograptus.

(*e*) Stipes and branches reticulated regularly without transverse bars, and united at base in a long stem terminating in a bulbous radicle. (Spencer.) } Rhizograptus.

(*f*) Stipes and branches free, numerous rudimentary branchlets on both sides, and also spine-like cell-dentacles. (Spencer.) } Acanthograptus.

2. Cellules on more than one side(?) or over the surface; axis central (as observed by Spencer). } Inocaulis.

III.

"Slender cylindrical branches, with tubular cellules arranged in a single (or in double?) series; cellules not in contact in any part of length." } Rastrites.

IV.

"Species having a common axis or rachis, with slender alternating branches; cellules unknown." } Thamnograptus.

V.

"Species having a common axis, more or less frequently bifurcating with pinnulæ closely and alternately arranged on the opposite sides; cell-apertures on one face of the pinnulæ." } Ptilograptus.

VI.

"A simple flexuous rachis, with slender flexuous flattened pinnulæ arranged in alternate order, at close and regular intervals, on the two sides. Cell-apertures unknown or circular." } Buthograptus.

VII.

"Strong stems which are numerously branched; branches and branchlets slender, arranged in whorls; cellules undetermined." } Oldhamia(?).

VIII.

Numerous simple short celluliferous stipes originating at a common centre and passing through a well-marked non-celluliferous disc and extending beyond its margin. (Spencer.) } Cyclograptus.

List and Range of the Genera found in the Niagara Group.

Genera	Range.
Graptolithus (Linnæus)	Quebec, Hudson River, Clinton.
Phyllograptus (Hall)	Quebec, Niagara(?).
Retiolites (Barrande)	Quebec, Clinton.
Dendrograptus (Hall)	Potsdam, Quebec, Niagara.
Callograptus (Hall)	Quebec, Niagara.
Dictyonema (Hall)	Quebec, Trenton, Clinton, Niagara, Helderberg; Corniferous, Hamilton.
Calyptograptus (Spencer)	Hudson(?),* Niagara.
Rhizograptus (Spencer)	Niagara.
Acanthograptus (Spencer)	Niagara.
Inocaulis (Hall)	Niagara.
Thamnograptus (Hall)	Quebec, Hudson, Niagara.
Ptilograptus (Hall)	Quebec, Niagara.
Cyclograptus (Spencer)	Niagara.

* I obtained a specimen called *Inocaulis arbuscula* (Ulrich), belonging to Cincinnati Group, which resembles and is probably a species of *Calyptograptus*.

CATALOGUE OF THE SPECIES OF THE GRAPTOLITE FAMILY BELONGING TO THE NIAGARA GROUP.*

Genus PHYLLOGRAPTUS (Hall).
- *Phyllograptus*(?) *dubius*, n. s.

Genus RETIOLITES (Barrande).
- *Retiolites venosus* (Hall).

Genus DENDROGRAPTUS (Hall).
- *Dendrograptus ramosus*, n. s.
- *Dendrograptus simplex*, n. s.
- *Dendrograptus dawsoni*, n. s.
- *Dendrograptus frondosus*, n. s.
- *Dendrograptus prægracilis*, n. s.
- *Dendrograptus spinosus*, n. s.
- *Dendrograptus* (*Chaunograptus*) *novellus* (Hall), 1879. Trans. Albany Inst., vol. x.

Genus CALLOGRAPTUS (Hall).
- *Callograptus niagarensis* (Spencer), 1878. Can. Nat.
- *Callograptus granti*, n s.
- *Callograptus* (*Dendrograptus*) *multicaulis*, n. s.
- *Callograptus minutus*, n. s.

Genus DICTYONEMA (Hall).
- *Dictyonema retiforme* (Hall), 1852. Pal. N. Y.
- *Dictyonema gracile* (Hall), 1852. Pal. N. Y.
- *Dictyonema websteri* (Dawson), 1868. Acad. Geol.
- *Dictyonema splendens* (Billings), 1874. Can. Pal. Fossils.
- *Dictyonema tenellum* (Spencer), 1878. Can. Nat.
- *Dictyonema expansum*, n. s.
- *Dictyonema pergracile* (Hall & Whitfield), 1872. 20th Report of N. Y. State Mus. N. H.

Genus CALYPTOGRAPTUS (Spencer).
- *Calyptograptus cyathiformis* (Spencer), 1878. Can. Nat.
- *Calyptograptus subretiformis* (Spencer), 1878. Can. Nat.
- *Calyptograptus micronematodes*, n. s.
- *Calyptograptus*(?) *radiatus*, n. s.

Genus RHIZOGRAPTUS (Spencer).
- *Rhizograptus bulbosus* (Spencer), 1878. Can. Nat.

Genus ACANTHOGRAPTUS.
- *Acanthograptus granti* (Spencer), 1878. Can. Nat.
- *Acanthograptus pulcher*, n. s.

Genus INOCAULIS (Hall).
- *Inocaulis plumulosus* (Hall), 1852. Pal. N. Y.
- **Inocaulis bellus* (Hall), 1852. Pal. N. Y.
- *Inocaulis walkeri*, n. s.
- *Inocaulis*(?) *problematicus* (Spencer), 1878. Can. Nat.

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* *Graptolithus clintonensis* of the Clinton of New York has not been found in Canada.

Genus Inocaulis diffusus, n. s.
Inocaulis ramulosus, n. s.
Inocaulis cervicornis, n. s.
Inocaulis phycoïdes, n. s.
Inocaulis divaricatus (Hall), 1879. Trans. Albany Inst.
Genus THAMNOGRAPTUS (Hall).
Thamnograptus(?) *bartonensis* (Spencer), 1878. Can. Nat.
Genus PTILOGRAPTUS (Hall).
Ptilograptus foliaceus (Spencer), 1878. Can. Nat.
Genus CYCLOGRAPTUS (Spencer).
Cyclograptus rotadentatus, n. s.

DESCRIPTION OF GENERA AND SPECIES.

GENUS PHYLLOGPATUS (Hall).

(Gr. *phullon*, a leaf; *grapho*, I write.
(Can. Organic Remains, Dec. ii., 1865.)

"Frond consisting of simple or compound foliiform stipes, which are celluliferous upon the two opposite sides, the margins having a mucronate extension from each cellule; or consisting of similar forms united rectangularly to each other by longitudinal axes, and furnished on the outer margins with similar cells; the whole supported on a slender radicle, or combined in groups."

One common species from the Niagara formation I have referred to this genus.

PHYLLOGRAPTUS(?) DUBIUS, nov. sp.

Plate I. Fig. 1.

Stipes strong and simple, tapering at both ends by gentle curvature, and traversed by a broad central depression and surrounded by a thinner substance (black and corneous). The cells are unknown, but the central axis has a jointed appearance, where each joint probably indicates the origin of a cellule. Each joint is a millimetre apart. The substance on each side is thin, and was probably traversed by cellules. The stipes usually are less than two centimetres long, although sometimes double that length. In thickness they usually vary from two to three millimetres, and the central axis is half the breadth of the stipe. In one or two specimens a second cross-stipe appears; this may be either one preserved accidentally, or derived from the first, although this branching form is not usual.

This fossil is exceedingly common and is generally only represented by bituminous incrustation with no structure visible.

Formation and Locality. — This structure is only found in the upper Niagara shaly dolomites, along Rosseaux creek bottom, east of Hamilton, Ontario. Like many other specimens of the family, it was first observed by Col. Grant.

GENUS RETIOLITES (Barrande).

Rete, a net; *lithos*, a stone.

"Frond simple(?) or compound. Stipeselongate, oval, or lanceolate, with longitudinal axis and reticulate structure; margins ornamented with mucronate points. Cellules developed in parallel ranges on opposite sides of the stipe and in contact with it throughout its entire length."

RETIOLITES VENOSUS (Hall).

Plate I. Fig. 2.

(Palæontology of New York, vol. ii., 1852.)

I have only seen one specimen of this species. The serræ are arranged alternately on both sides of the stipe at about one millimetre distant from each other, and form an angle with the stipe of about 45 degrees. They have a length of about two millimetres. The portion of the stipe obtained is about five centimetres long, and from two to three millimetres wide. The substance between the serræ (which is always very thin) is wanting, but the specimen is easily recognized by the peculiar serræ.

Formation and Locality.—This fossil occurs in the Clinton rocks at Hamilton, Ontario, and was obtained by Col. Grant.

GENUS DENTROGRAPTUS (Hall).

Dendron, a tree; *grapho*, I write.

(Can. Organic Remains, Dec. ii., 1865.)

"Frond simple or aggregate, consisting of a strong footstalk, which is sometimes furnished below with a distinct root or root-like bulb, and above is variously ramified and subdivided into numerous branches and branchlets, which are slightly divergent, the whole producing a broad, spreading, shrub-like frond (fronds sometimes flabellate?); branches celluliferous on one side; cellules appearing as simple indentations on the surface, and sometimes distinctly angular, with denticles conspicuous. In some specimens the cellules are indicated by prominent pustule-like elevations, arranged along the centre, or in subalternate order on one face of the branch. Substance of the stipe and branch corneous, solid, or tubular; surface striated."

A considerable number of species of the genus have been found at Hamilton by Col. Grant and myself. In most cases the cell-markings are poorly preserved, but many of the fronds, otherwise, are in a good state of preservation, and several are very beautiful.

Dendrograptus ramosus, nov. sp.

Plate I. Fig. 3.

Frond moderately flabelliform. The base of the frond arises from a single stipe, and from near its summit most of the branches originate, and moderately diverge above, with few bifurcations. The texture is corneous, with the surface strongly striated. The cellules are arranged along one of the margins of the branches, and have angular openings, processes, or cell-denticles, marking these openings as in fig. 3*a*, which is a branch enlarged.

The largest frond is four centimetres high, exclusive of the broad stipe, of which the length of a centimetre is preserved. It expands above in straight radiating branches until the summit is rather more than three centimetres across. The not-very-numerous branches are comparatively stout, being about a millimetre broad. The branches occasionally touch or overlap, but this arises from the manner in which they were compressed in the rock. This species is easily distinguished from any other of the group that is obtained at Hamilton.

Formation and Locality.— This fossil is found in the more shaly dolomites below the "Chert beds" of the Niagara formation, at the "Jolly-cut road," Hamilton, Ontario."

Dendrograptus simplex, nov. sp.

Plate I. Fig. 4.

Frond erect, with strong branches originating from a lengthy flexuous stipe, and diverging slightly above. The branches bifurcate only once or twice and are closely crowded together. Transverse bars are apparent in one or two places. The texture is corneous, with surface striated. On one side there are oval depressions marking the cell-orifices; these are nearly a millimetre in length, and are situated about double that distance apart. Rudimentary branches are given off on each side of the stipe.

Of this species I have only one specimen. It is five centimetres high, besides the single basal stipe, which is nearly two centimetres long. The branches diverge from their initial points on the stipe until the summit is rather more than a centimetre broad, although there are six or seven branchlets present, each having the breadth of a millimetre, and situated about the same distance apart.

Formation and Locality.— This specimen was found in the Niagara dolomite at the "Jolly-cut road," Hamilton, Ontario.

DENDROGRAPTUS DAWSONI, nov. sp.

Plate I. Fig. 5.

Found erect and tree-like. Stipe short, but extending upward and dividing into two or three principal branches, each bifurcating twice or thrice, and at the same time giving off several slightly diverging branchlets at irregular distances on both sides. The lower part of the stipe or trunk also gives off several branchlets. The outline of the frond is cleft or divided into somewhat rounded lobes, with branches more or less upright. The corneous surface is strongly marked with striations. The cellular openings are oval on one side of the axis, as represented in fig. 5*a*. However, there are undulations or swellings on some of the surfaces.

This little fossil is one of the most beautiful of the Graptolite Family found in the Niagara formation. It is four centimetres high and with a breadth of two centimetres, while the branches are less than half a millimetre thick, and nearly double that distance apart. There is a strong resemblance to *D. fructicosus* of the Quebec group. Only one good specimen is in my possession.

Formation and Locality.—This specimen was obtained by Col. Grant in the dolomitic shales, below the "cheit bed" of the Niagara formation, at the "Jolly-cut road," Hamilton, Ontario.

DENDROGRAPTUS FRONDOSUS, nov. sp.

Plate I. Fig. 6.

The frond is low and broadly flabellate, originating from a short slender stipe, which divides twice or thrice, after which the divisions extend to the summit of the several lobes, and send off branches at irregular distances on both sides. The branches give rise to lateral branchlets rather than bifurcations. The branches are short and slender, not exceeding one-third of a millimetre in thickness. The surface is striated; the cellular openings are minute and oval, but usually indistinct. Fig. 6*a* represents an enlarged branch.

This graceful little frond is less than two centimetres broad, and one and a quarter centimetres high.

Formation and Locality.—It occurs in the Niagara dolomite at Hamilton, Ontario.

DENDROGRAPTUS PRÆGRACILIS, nov. sp.

Plate I. Fig. 7.

Frond diffuse. The branches, few in number (three or four), originating from a long slender stipe, with each sending off small-er, very slender branchlets. Surface striated, and celluliferous on one side. Branches about quarter of a millimeter broad and di-verging considerably. The umbeliferous summit is about as broad as high (measuring one and a half centimetres, besides the long stipe).

The mode of branching and general appearance of this fossil closely resembles *D. gracilis* of the Quebec group, only it is much smaller.

Formation and Locality. — It occurs in the Niagara dolomite at Hamilton, Ontario.

DENDROGRAPTUS SPINOSUS, nov. sp.

Plate I. Fig. 8.

Frond small and shrub-like, with long flexuous stipe extending to the summit, and giving off branches, usually alternate and at unequal distances, and diverging from each other at considerable angles. From both stipe and branches there are numerous spine-like branchlets, which sometimes have dichotomous terminations. The surface is striated, but the cellular structure is not preserved. The branches vary from one-third to one-half of a millimetre (in different specimens) in thickness, with somewhat greater dis-tance between. The frond is usually twice as long as wide, and varies from one and a half to two centimetres high.

Formation and Locality. — This graceful little fossil is found in the "cherty beds" of the Niagara dolomite, at the "Jolly-cut road," at Hamilton, Ontario.

DENDROGRAPTUS (s. g. CHAUNOGRAPTUS) NOVELLUS (Hall).

(Trans. Albany Inst., vol. x.. 1879; Geology of Indiana, 12th Rep't, 1882.)

"Fossils occurring free in shales, or upon other fossil bodies, in slender branching fronds. Branches diverging lax, and slender, with numerous branchlets, both marked by numerous cellules, which are usually indicated by the appearance of abrupt expansion and contraction of the branches."

This very small Indiana species is probably represented at Hamilton, Ontario.

GENUS CALLOGRAPTUS (Hall).

Gr. *kallos*; beautiful; *grapho*, I write.

(Canadian Organic Remains, Dec. ii.)

"Flabellate fronds, with numerous slender bifurcating branches proceeding from a strong stem on axis Branches and divisions celluliferous on one side, the opposite side striate; sometimes distantly and irregularly united by transverse dissepiments. The non-celluliferous side sometimes presents a semi-reticulate appearance."

Several species of organisms occur in the Niagara rocks at Hamilton which can safely be placed in this genus. As remarked by Prof. Hall, the genus stands intermediate in general appearance between *Dictyonema* and *Dendrograptus*. In *Callograptus* there is no reticulate appearance, and the various bifurcating branches diverge from a common radicle and are free and independent, unlike the arrangement in *Dictyonema*. Nor do the branches overlie or interlace with each other as in *Calyptograptus*. In all the species that I have placed in this genus, the branches originate in snch a manner as more nearly to resemble the outline of a bush rather than of a tree, and in some cases the frond has a semicircular appearance. Some of the species resemble so closely those of the Quebec group, that they might almost be considered as varietal forms.

Prof. Hall has remarked that some species have grown in funnel-shaped ponds. I have also placed one or two species that may be of that character, where the mode of branching is entirely free, in this genus. It is possible that some species that have been placed here might rather be placed with the genus *Dendrograptus*, which this genus nearly resembles.

Callograptus niagarensis, nov. sp.

Plate I. Fig. 9.

Callograptus niagarensis (Spencer), Can. Nat., vol. viii., No. 8, 1878.

Frond flabellate, with slender branches more or less parallel; form nearly semicircular, with branches radiating from a common axis. In texture it is corneous, with the surfaces of the flattened branches marked with striations, appearing like cell-impressions, while on the reverse side minute oval pits or points indicate the apertures of the cells, of which there are as many as twelve in a centimetre, the longest diameter of the cell-orifice being about half a millimetre.

The frond does not usually exceed four centimetres in breadth, being broader than high. The branches are a little less than half a millimetre broad, with spaces between them sometimes exceeding a millimetre in breadth.

This species is easily distinguished from *Dictyonema* by the absence of cross-bars, and by the branches of frond being free. By the mode of branching, this species can be distinguished from *Dendrograptus* even if the cellules are obscured.

Formation and Locality. — This species occurs in the Niagara dolomites and shales at Hamilton, Ontario.

Callograptus granti, nov. sp.

Plate I. Fig. 10.

Frond originating from a single stipe; branches slender, and bifurcating two, three, or four times, and principally originating near the common radicle. In spreading gently above in undulations the branches are more or less parallel and situated closely together, and are connected occasionally with exceeding fine transverse bars. The texture is corneous, with the surface obliquely striated and marked with ellipsoid pits, which in some places indicate the orifices of the cells, of which there were about two for every millimetre of length of branch. (See Pl. 1, fig. 10*a*.) The branches are rarely connected by minute cross-bars.

The general outline is that of a regular oval form, whose length, in the most perfect specimens, is three centimetres (besides the common stipe, which extends another centimetre), and breadth, two centimetres. The branches are not more than a quarter of a millimetre broad, while the stipe is about double that thickness.

This exceedingly beautiful frond in general appearance closely resembles *C. salteri* of the Quebec group, but somewhat smaller, although there is some variation in the size of this species.

Formation and Locality. — This species occurs on the shaly surfaces of the Niagara dolomites at Hamilton, Ontario.

Callograptus multicaulis, nov. sp.

Plate I. Fig. 11.

Fond flabellate, possibly funnel-shaped in its growing state; branches, with two or three bifurcations, strong and somewhat numerous. Surfaces deeply striated longitudinally. The branches radiate from a common radicle until they occupy three-fourths of a circle; but whether they extended all around, and the frond grew in a funnel shape, cannot be determined, as the lower branchlets are crushed and obscured. This beautiful little fossil has about a dozen principal branches well preserved, and these are about half a millimetre broad, with rather greater space between. The length of each branch is slightly over a centimetre, and the breadth of the frond about double that measurement. Cells are not known.

Formation and Locality.—This graceful fossil was obtained from a more shaly bed of dolomite, below the "chert bed" in the Niagara formation, at the "Jolly-cut road," Hamilton, Ontario.

Callograptus minutus, nov. sp.

Plate I. Fig. 12.

Frond orbicular. Branches, with one or two bifurcations, regularly diverging from the initial point like the venations of a palm-leaf: they are all free. The surfaces are striated. The branches do not exceed one-fifth of a millimetre in breadth, and are about half a millimetre apart. The whole height of the frond is a centimetre, and the greatest breadth somewhat less.

Formation and Locality. — This species occurs in the Niagara dolomite at Hamilton, Ontario.

Genus DICTYONEMA (Hall).

Gr. *diktuon*, *a* net; *nema*, a thread.

(Palæontology of New York, vol. ii.)

"Frond circular or flabelliform, composed of slender radiating branches which frequently bifurcate as they extend towards the margin; branches and subdivisions united laterally by fine transverse dissepiments; branches impressed with deep striæ of grooves, producing indentations that sometimes have an elongated rhomboidal form; axis subcalcareous, with a corneous exterior." (Hall.)

The branches generally appear as black threads on the stone, but these can be distinguished from Fenestella by the corneous character, even in indistinct fragments. In one species, at least, I have seen the axis well represented. In *D. gracile*, the cells are circular or ellipsoid-cylindrical, extending into the cœnosarc or even common canal; they are situated on one side of the stipe only. In another species only oval pits mark the cell-apertures. The striæ are probably caused by the depression of the common canal between (or at the junction of) the cellules, and thus representing the general position of the polypite. In *D. gracile* Prof. Hall represents the cell-orifices as characterized by denticles; in our collections this is not represented, although I have a very fine specimen before me that shows the cells. The size of the different species varies considerably, the largest frond seen being 25 centimetres in diameter. All of the more perfect specimens, whether of funnel-shaped or fan-shaped fronds, obtained here, show more or less of a solid radicle by which they were probably attached.

Geological Range. — The species of fossils placed in this genus are found in the Quebec, Trenton, Niagara and Hamilton formations; thus existing from the Upper Cambrian to the middle Devonian ages.

Dictyonema retiforme (Hall).

Plate 3. Figs. 1 & 2.

(Palæontology of New York, vol. ii.)

" Frond circular, or expanded cyathiform in its growing state (flattened in its fossil condition); branches thin, flat, frequently bifurcating, united laterally by obliquely transverse filaments, leaving oblong-quadrangular interstices; surfaces of branches indented, intermittingly striated in an oblique direction."

The better preserved specimens appear to have been cup-shaped, and, when flattened out, they have become sometimes circular, but more frequently they have fallen on one side and assumed a flabellate form, with sides largely expanded and radiated from the root as a circular frond. The branches are comparatively broad, averaging a millimetre, or twice the breadth of those of *D. gracile*, and the transverse bars are comparatively stout. The radicle or initial point is often well preserved. Two specimens before me are about 12 centimetres high and 25 broad. Few perfect specimens can be found.

Formation and Locality. — In New York it is found throughout the Niagara shales at Lockport and elsewhere. In Canada, it occurs at Grimsby and at Hamilton, in the somewhat earthy dolomites beneath the chert-bed.

Dictyonema gracile (Hall).

Plate 2. Fig 2 represents a fragment, and Fig. 3 represents a celluliferous portion of a frond enlarged (found at Hamilton).

(Palæontology of New York, vol. ii.)

"Frond circular or flabelliform (probably cyathiform in its growing state), composed of slender bifurcating and slightly diverging branches, which are united laterally and at long intervals by very slender filaments; branches irregularly striated or indented, sometimes having uneven or subserrate margins; texture like *D. retiforme*, with an outer black filament and interior subcalcareous stipe." (Hall.)

In this species the branches are much more slender than in *D. retiforme*, averaging about half a millimetre in breadth and twice that distance apart. The branches are regularly arranged and form fan-shaped fronds, but many specimens indicate the cyathiform structure while living. Though the margins are generally even, yet in one fine specimen the terminations of the branches are irregular. The fronds converge to what is evidently a non-celluliferous radicle, and in size the finest specimens are as much as 10 centimetres high and 6.5 broad.

The transverse filaments, which are non-celluliferous, are from four to five times as far apart (sometimes much farther) as the branches; or are frequently obliterated, or almost so. The texture is corneous.

The celluliferous structure is shown in very few specimens. However, one specimen (Plate 2, fig. 3), in particular, which I obtained from Mr. A. E. Walker of Hamilton, removes all doubt as to the character of the cellules. On one side of the branch there is a slender solid axis, in the other there are inserted cylindrical calycles which penetrate the common canal (or cœnosarc) almost to the axis. The cells have their own distinct cell-walls; they are cylindrical in form, about 0.5 mm. long and mm. 0.35 in diameter. The portion of the cell towards the orifice overlies the base of the next cell, so that there are from 25 to 32 calycles in the length of a centimetre. More frequently only circular, or ellipsoid, elevated (sometimes depressed) points mark the former abodes of the polypites, which, being surrounded by a denser texture, have not yielded to the pressure which has flattened the walls of the common canal. The irregular striæ and depressions on the stipes and branches are probably occasioned by the unequal flattening of the canal and celluliferous portions of stipes.

This species is the most easily obtained of the fossils of the group, though good specimens are very uncommon. Generally we must identify them by the relative size and arrangements of the branches and filaments, or, in more perfect specimens, by the form of the frond.

Formation and Locality.—Since the geological survey of New York first obtained this fossil in the Niagara shales at Lockport, it has been found at Grimsby, and more particularly at Hamilton, Ont., by Col. Grant, Mr. A. E. Walker, and myself, in the earthy, magnesian limestones of the lower portion of the cherty-bed, and in shaly rocks adjacent to it. (See geological section at Hamilton.*) It also occurs near Louisville, Ky.

DICTYONEMA EXPANSUM, nov. sp.

Plate 2. Fig. 1.

Frond flabelliform, composed of slender expanding and bifurcating branches, diffusely arranged, and united laterally by slender filaments (often wanting); branches irregularly striated; texture corneous.

This species is clearly related to *D. gracile* in the relative size of the branches, but these are much more diffusely and irregularly arranged, with greater interspaces, which are from two to four times the width of the branches. The transverse filaments occur less frequently than in *D. gracile*. Fragments of this species are not always easily distinguishable from *D. gracile*, although the branches are looser and more spreading. The type-

* In Paleozoic Geology of the Region of the West End of Lake Ontario, by J. W. Spencer. Can. Nat., 1882.

specimen is eight centimetres high and about sixteen broad, rising from a united base of five or six stipes.

Formation and Locality. — Niagara limestones at Hamilton, Ontario.

DICTYONEMA WEBSTERI (Dawson).

(Acadian Geology, 1868.)

This beautiful frond occurs at New Canaan, Nova Scotia, in fawn-colored slate of the Upper Silurian system. It is cellulifer-ous on one side, and in appearance it is more closely related to *D. retiforme* than to *D. gracile*.

DICTYONEMA TENELLUM, nov. sp.

Plate 1. Fig. 13.

Dictyonema tenellum (Spencer). Can. Nat., vol. viii., No. 8. 1878.

Frond cyathiform in the growing state, but usually circular on the rock. The branches uniform, diverging slowly from the radicle-centre to the margin with bifurcations; in width averaging 0.3 millimeters, and connected at short intervals by very delicate transverse dissepiments; margin entire. The frond is of a corneous character like the other species of this group.

In the best specimens distinct ellipsoid pits are arranged along the sides of the branches, marking the position of the calycles, these having the longer diameter equal to half a millimetre and their shorter occupying two-thirds of the width of the stipe. There are about twenty-four of these calycles arranged longitudinally in the length of a centimetre. In specimens less perfectly preserved the bars connecting the branches are almost obliterated, and in those in a better state of preservation they are placed from two to three millimetres apart, while between the branches there are not usually spaces as great as (or greater than) their own width.

This species is easily distinguished from *D. gracile* by the branches being much finer, less diverging, with more bifurcations, by the transverse bars being more closely arranged and the frond regularly circular, having no general bush-like form that is seen in most specimens of that species. The largest frond is nine centimetres in diameter.

Formation and Locality.—It occurs at Hamilton, Ontario, in the dolomitic limestone of the cherty beds and in the underlying more shaly rocks. It was first collected by Col. Grant.

DICTYONEMA SPLENDENS (Billings).

(Canadian Palæozoic Fossils, vol. ii., part 1, 1874.)

"Frond four or five inches in length and width; longitudinal stems about one-third of a line wide, and about their own width distant from each other. The connecting bars or dissepiments are very slender and fragile. They seem to vary in distances from half a line to 3 lines. It is probable that, when perfect, they are at a uniform distance of about half a line, and that when they are more remote some of the intermediate ones have not been preserved. The substance of the stipes is rough, black and shining, and apparently with some irregular longitudinal striæ.

"No cells or serrations can be seen in any specimens examined. There are five or six longitudinal stipes in the width of two lines." (Billings.)

Formation and Location. — Between Cape Gaspé and Cape Rosier, Province of Quebec, in Upper Silurian limestone.

DICTYONEMA PERGRACILE (Hall and Whitfield).

(24th Report of N. Y. State Museum of N. H., 1872.)

"Fronds irregular, spreading, composed of very fine closely arranged meshes. Longitudinal filaments tortuous, not exceeding a fiftieth of an inch in width, and the spaces between about equal. Transverse filaments much narrower than the others, their distance equal to twice or thrice that of the longitudinal ones, giving to the openings an elongate hexagonal form. Serrations of the margins not observed. Surface of filaments minutely wrinkled." (H. & W.)

Formation and Locality.—Niagara limestone, Louisville, Ky.

GENUS CALYPTOGRAPTUS.

Gr. *kaluptos*, overlaid; *grapho*, I write.

Genus *Calyptograptus* (Spencer). Can. Nat., vol. viii., No. 8, 1878.

Frond cyathiform or flabellate, with numerous bifurcating branches, which are dichotomous or trichotomous at their terminations, but are not connected by true lateral processes. The branches are marked with striæ resembling rhomboidal pits; the axis has a black corneous exterior, and the radicle is composed of a thickened mass of the same texture as the branches. In appearance and texture this genus resembles *Dictyonema*, but the branches are apparently all independent, not being connected by transverse dissepiments, as in that genus (although some of the branches touching each other have occasionally the appearance of connecting filaments), and are only united in one mass at the root. When fallen some of the branches overlie others as in a semi-anastomose structure; the form may be circular or fan-shaped. Four species of this genus are known.

CALYPTOGRAPTUS CYATHIFORMIS, nov. sp.

Plate 3. Fig. 3.

Calyptograptus cyathiformis (Spencer). Can. Nat., vol. viii., No. 8, 1878.

Frond cyathiform, with numerous bifurcating branches, united only at the base, with no lateral processes. The axis consists of a black corneous substance, which is striated longitudinally. The fallen frond has some of the branches overlying each other, giving somewhat the appearance of an irregular net-work. The radicle consists of a well marked, thick, corneous mass. The branches are divided into two or three small terminations, which probably mark the beginning of new branches. The branches are rather over one millimetre in breadth. The specimen under consideration is most interesting. When obtained the frond had a general flabellate form with the radicle well-marked, having branches radiating to nearly a semi-circle; but, on trimming the specimen, the portion of the stem with the radicle was chipped off, and revealed the remainder of a beautiful frond which was now shown to be circular, the frond having been bent partly over in the mud, and having the lower portion covered before the whole was flattened in the sediment—thus proving the funnel-shaped character when living.

Only one specimen has been found; this is six centimetres in diameter, and from the base of the root to the top of the branches it measures four centimetres.

Formation and Locality. —It occurs in the Niagara limestone beneath the "chert-bed" at the "Jolly-cut," Hamilton, Ont.

CALYPTOGRAPTUS SUBRETIFORMIS, nov. sp.

Plate 4. Figs. 1 & 2.

Calyptograptus subretiformis (Spencer). Can. Nat., vol. viii., No. 8, 1878.

Frond circular or flabellate, but cyathiform in its growing state. There are numerous bifurcating branches, which in the fossil condition imperfectly unite or overlie each other, producing a kind of fine net-work with irregular ellipsoid interstices. In texture it is corneous, and has the branches marked with striations of a sub-rhomboidal form. The terminations of the branches are dichotomous.

In this species the branches are finer than in *C. cyathiformis* (varying from 0.35–0.75 of a millimetre in breadth), with more numerous and irregular bifurcations. The small branches overlie (or are connected with) each other, giving a netted appearance, and sometimes there is the resemblance to cross-bars as in Dictyonema; but from this genus it is easily distinguished by want of a system of cross-bars, and by the very irregular branches, and irregular or ellipsoid meshes of the net. The frond is sometimes flattened in a circular (and sometimes in a fan-shaped) form, showing the basal extremity as if attached. My largest specimen is ten centimetres high, and when complete it had as great a breadth near the summit.

Formation and Locality.—This species is found principally in the shaly dolomites below the "chert-bed" of the Niagara formation at the "Jolly-cut," Hamilton, Ont.

CALYPTOGRAPTUS MICRONEMATODES, nov. sp.

Plate 3. Fig. 4 and 4*a*.

Frond cyathiform in its growing state, with numerous lateral branches originating from the older stipes. The branches overlie each other, and may be united in some cases, but without true cross-bars. The whole frond has an anastomose appearance with irregular rhomboidal interstices. The texture is corneous (though sometimes replaced by pyrites, and the surface is marked with longitudinal striations, which in some places appear to represent the position of a solid central axis. The terminations of the branches end in two or three points. The branches in this species are very delicate, being about a quarter of a millimetre broad, and each branch is not more than from one to two millimetres in length, before it overlaps or touches the adjacent stipe. The greatest diameter of the frond is not more than four centimetres. Only two or three specimens of this beautiful little frond have been obtained.

Formation and Locality. — I obtained this species, near the base of the Niagara dolomite, at a quarry just west of the "Jolly-cut road." Hamilton, Ont. This species is also found near Louisville, Ky.

CALYPTOGRAPTUS(?) RADIATUS, nov. sp.

Plate 4. Fig. 3.

Frond ellipsoid, but cyathiform in its growing state. Numerous delicate branches, with two or three bifurcations, radiating from a common radicle. Some of these touch or overlie each other, but they are quite unconnected. The texture is corneous, with the surface striated and marked with minute depressions or pits, which indicate the former position of the cellule. These depressions are about the fourth of a millimetre in diameter, with an equal space between. The branches are about one-third of a millimetre broad. The greatest diameter of the frond is less than three centimetres. Fragments of this species so resemble species of *Callograptus* that they could not be readily distinguished; but in no species of the latter genus is the conspicuous funnel-form apparent.

Formation and Locality.—This fossil occurs in the "cherty-beds" of the Niagara dolomite at Hamilton, Ontario.

GENUS RHIZOGRAPTUS.

Gr. *rhiza*, a root; *grapho*, I write.

Genus *Rhizograptus* (Spencer). Can. Nat., vol. viii., No. 8, 1878.

Frond flabellate, but cyathiform in its growing state; bifurcating branches with dichotomous terminations; stem terminating in a well-marked bulb; branches (marked with striæ) more or less reticulated and united, or overlaid, by others.

This genus is established on account of its bulbous root, which, as yet, has been found in no other variety. The numerous branches closely overlie each other, or are connected in the form of a net-work, without transverse dissepiments. Fragments of specimens belonging to this genus somewhat resemble species of *Calyptograptus*, but have a much more regularly netted appearance, and the branches are much more delicate.

RHIZOGRAPTUS BULBOSUS, nov. sp.

Plate 4. Fig. 4.

Rhizograptus bulbosus (Spencer). Can. Nat., vol. viii., No. 8, 1878.

The frond is cyathiform in growing state; numerous bifurcating branches overlie each other, or are united at points of contact to form a net-work, with fine, more or less irregular, rhomboidal interstices. The branches unite at base into a slender non-celluliferous axis which terminates in a bulbous root. The striæ along the branches (which vary in thickness from a quarter to a third of a millimetre) appear to mark the depressions of the common canal between the original positions of the polypites. The orifices of the cellules have an ellipsoid form, and there are about four of these for every millimetre of length. On the side of the stipe opposite to the cellules there is a solid axis. In some specimens there are occasional spine-like projections which are probably rudimentary branchlets. The texture is corneous, although this is sometimes replaced by pyrites. The typical specimen is about five centimetres high.

Formation and Locality.—This species was found by Col. Grant, near the base of the "chert-bed" of the Niagara dolomite, at the "Jolly-cut," Hamilton, Ont.

Genus ACANTHOGRAPTUS.

Gr. *akantha*, a thorn; *grapho*, I write.

Genus Acanthograptus (Spencer). Can. Nat., vol. viii., No. 8, 1879.

Fond shrub-like, consisting of thick branches, principally rising from near the base, with little divergence and some bifurcations. One side of the branches, furnished with prominent spines or denticles, appearing to mark the position of the apertures of the cells. Texture corneous, and indistinctly striated longitudinally.

This generic form resembles some species of *Dendrograptus*, but the branches are stronger and more bushy than those of the species of that genus, and have conspicuous spines, in whose axils the cellules were probably situated.

Acanthograptus granti, nov. sp.

Plate 4. Fig. 5.

Acanthograptus granti (Spencer). Can. Nat., vol. viii., No. 8, 1878.

Frond shrub-like, with thick branches principally originating near the base. Some of the branches bifurcated with dichotomous terminations ending in free points. Cell-apertures conspicuous on one side only, and situated in the axils of the prominent spines. Surface longitudinally striated. Occasionally there are rudimentary denticles appearing also on the opposite side of the branch as well as on that marked with the regular spine-like projections, of which there are six or seven in the length of a centimetre of the stipe, which is characterized by obscure indications of a solid central axis. The branches average a millimetre in breadth, and the spines are sometimes a millimetre long, which in some places extend into the material of the stipe to its centre. The flattened frond is usually four or five centimetres high and about four wide, and consist of fifteen or twenty branches at half its height, which are somewhat more numerous at the summit owing to occasional bifurcations. The whole frond originates from a common radicle.

The best preserved graptolites that are found at Hamilton occur on the shaly surface of the limestone, but this species is only found in the highly crystalline rock, and consequently, although the general form of frond is well-preserved and very beautiful, the detailed structure is not shown as well as in the forms that are found in the more perishable shaly rocks.

Formation and Locality.—This species is found in the dolomitic limestones of the Niagara formation at Hamilton, Ont., and was first discovered by Col. C. C. Grant, after whom it is named.

ACANTHOGRAPTUS PULCHER, nov. sp.
Plate 4. Fig. 6.

This frond is broadly flabellate, but was possibly cyathiform in its growing state. Very numerous branches (with few principal subdivisions) arise from a common radicle and extend in an entirely free manner to the even, and more or less circular, margin of the frond. Along both sides of the branches many short rudimentary branchlets arise. Besides these there are numerous spine-like processes, which possibly indicate the position of the cellules. The texture is corneous, with the surface striated, and in some places, where removed, there are indications of a lateral solid axis. From the centre of the radicle the branches extend a distance of about two and a half millimeters to the margin of the ground, or the diameter is about five millimetres. The branches are half a millimetre thick. The rudimentary branchlets, irregularly situated, are seldom more than two millimetres long, and are stout, while the spine-like processes have a length of half a millimetre, and are about the same distances apart, being very slender.

The branches of this exceedingly beautiful frond (as I have only one complete specimen) appear to have occupied a semi-circular position when alive, but in compression has so fallen as to extend nearly in the form of a circle. Though it resembles somewhat *Callograptus niagarensis*, yet the numerous rudimentary branchlets and spine-like processes distinguish it from that species.

Formation and Locality.—This species is found in the "chert-beds" of the Niagara formation at Hamilton, Ontario. The best specimen was obtained from Mr. Edward McLaughlin of Hamilton.

GENUS INOCAULIS (Hall).

Gr., *inos*, sprouts (like roots of herbs); *kaulos*, a stock or stem.

(Palæontology of New York, vol. ii., 1852.)

"A plant like corneous coral, with numerous bifurcating branches; structure fibrous or plumulose."

"The texture of this coral is similar to the Graptolites, a black scaly crust or film being all that remains of the substance. From the specimens examined it appears to have grown in groups, with rounded or flattened stems, which are dichotomous above and more or less spreading."

This genus was described with *I. plumulosus* for a type. Subsequently Professors Hall and Whitfield published and figured *I. bellus* in the second volume of Palæontology of Ohio, and *I. divaricatus* in 11th Report of Geology of Indiana. I described *I.*(?) *problematicus* (a common but poorly preserved species) in the Canadian Naturalist, Dec., 1878; and now I venture on the descriptions of *I. diffusus*, *I. cervicornis*, *I. ramulosus*, *I. phycoides*, and *I. walkeri*. With regard to the species of *Inocaulis* in my collection, the structure is shown somewhat more or less perfectly in several of the species. Some of the species appear to have grown in groups. In four species, at least, a central axis is indicated, one of these being *I. plumulosus*. Prof. Hall placed *Inocaulis* among those branching *Graptolites* which have cellules on only one side of the stipe, owing to the inability of recognizing the cellular structure in the American specimens. The diprionidian Graptolites (or those which have a row of cells on both sides) have their solid axis in a central position, as is also shown in four species, including the *I. plumulosus* found at Hamilton, Ontario. Even in most of the species that I have obtained, the definite cell-structure is not perfectly indicated. But from the fact that the axis is central, as will be shown in the description of the various species, the inference would be (even where the cells are not apparent) that the stipe was characterized by a row of cells on more than one side. Recently, in two species I have observed the surfaces of the fronds marked by numerours small pits indicating the cell-orifices situated variously all around the stipe. But the texture, the general arrangements of the branches, and the forms of the fronds, resemble sufficiently *Inocaulis plumulosus* to induce me to place them along with it in the same genus.

INOCAULIS PLUMULOSUS (Hall).

Plate 5, Fig. 1. (Specimen from Hamilton.)

(Palæontology of New York, vol. ii.)

"Stem flattened, dichotomous; structure fibrous or plumulose, apparently composed of imbricating elongated scales or fibres which spread equally on all sides." (Hall.)

In the specimens under consideration, all that generally remains of the texture is the scaly crust or dark organic film, not even showing the feather-like margins. But in several specimens where the carbonaceous matter is removed, there is the distinct imbricating scaly surface mentioned by Prof. Hall. During the summer of 1880, I obtained two specimens from Col. Grant which show a cellular structure. In a number of specimens I observed a central axis—indicating a cellular system on both sides of the stipes; but in the specimens just referred to there are minute points arranged over and around the surface of the stipes (the intercellular spaces being much greater than the cellular), and indicating the orifices of the cellules. This latter structure is shown where the corneous matter is mostly removed.

The entire fronds are seldom found. The branches vary considerably in size, from two to four millimetres in breadth, and from six to ten millimetres in height. There are generally few branches, but the fronds grew in groups and have often left confused masses of branches on the stone.

Formation and Locality. — This species is found at Lockport, Rochester, and other places in New York, in the Niagara shales; also at Hamilton, Ontario, in the Niagara limestones, especially in the "chert-beds" at the "Jolly-cut road."

INOCAULIS BELLUS.

Hall & Whitfield. Pal. Ohio, vol. ii.

"Frond small, diffusely branched, originating in a single stipe at the base, and spreading above; branches narrow and varying much in width, the strongest not exceeding three-hundredths of an inch, with frequent projecting, prong-like processes rising from the sides; bifurcations numerous at varying distances. Substance of frond thin, carbonaceous; the surface marked with longitudinal corrugations, irregularly disposed on most parts and on some of the larger branches, terminating at the upper end in a pustule or free point projecting outwards and upwards from the surface."

Professors Hall and Whitfield further remark that the corrugations on the surface of this species resemble those of some species of *Dictyonema*, though in mode of growth, in the absence of transverse filaments, and in other characters, it differs from it.

Formation and Locality.—Only one specimen of this species was found on the shaly surface of the Niagara limestone at Yellow Springs, Ohio; nor has it been found at Hamilton, although a closely allied species, *I. diffusus* (Spencer), has been obtained. This species has also been found near Louisville, Ky.

INOCAULIS DIVARICATUS (Hall).

(Trans. Alb. Inst., vol. x., 1879; 11th Report of Geology of Indiana, 1882.)

"Frond ramose, regularly branching at intervals about ten millimetres by dichotomous division. Branches straight; diameter 2 mm., diverging at an angle of nearly 85°, giving the frond a somewhat rigid appearance. Exterior structure composed of numerous irregular, longitudinally striated, branching filaments, connected by slender dissepiments, forming rows of small, irregular, subangular cell-apertures." "There is an absence of projecting, imbricating scales forming the cell-margins." (Hall.)

Formation and Locality.—Niagara limestones at Waldron, Ind.

INOCAULIS WALKERI, nov. sp.

Plate 5. Fig. 2.

Frond strong, with spreading branches, the margins having a plumulose appearance; structure corneous with a central axis, and the surface covered with minute points representing the cell-apertures.

This frond somewhat resembles *I. plumulosus*, but is slighter, and the branches (not exceeding 1.5 mm. in thickness) are much more numerous, and proceed from a single stipe. The type specimen has a height of eight and a breadth of six centimetres.

Formation and Locality. — This species occurs in the Niagara limestones at Hamilton, Ontario.

INOCAULIS PROBLEMATICUS, nov. sp.

Plate 5. Fig. 3.

Inocaulis problematicus (Spencer). Can. Nat., vol. viii., No. 8, 1878.

Plant-like, with small slender bifurcating branches; fronds aggregated, resembling branching rootlets; texture corneous with irregular corrugations. The height of the individual frond does not appear to have been more than two or three centimetres, with comparatively few branches which are about three-fourths of a millimetre broad. Yet the individuals appear to have grown in bunches or groups, and one specimen indicates a large number of fronds originating from a common rootstock, whose branches, though only three centimetres high, cover seven or eight centimetres in breadth.

The texture is generally poorly preserved, and is often represented only by stains on the surface of the stone. More commonly the fossil consists of an irregular mass of small branches lying together and occupying space on the stone not greater than nine or ten square centimetres.

The relation of this species is doubtful, but it is of such common occurrence that it becomes necessary to notice it.

Formation and Locality.—This is a common species in the dolomite limestones of the Niagara formation at Hamilton-cut.

INOCAULIS DIFFUSUS, nov. sp.

Plate 5. Fig. 4.

Frond originating in a single stipe at base, and rising above in numerous widely extended branches, averaging about a millimetre in breadth, with dichotomous terminations; branchlets originating more frequently on one side than on the other. Texture corneous with surface more or less regularly striated, leaving in some places small oval impressions (probably the orifices of the cellules.)

Of this species I have seen only one good specimen (and two inferior fragments which probably belong here). The frond is six centimetres high, and of still greater breadth. One of the branchlets at the dichotomous termination is much more slender than the other (a sort of lateral pustule), indicating probably the commencement of the growth of a new branch.

The general form of this species is like *I. bellus* (Hall & Whitfield), but it is much larger in size, having more diffused branches, with an entire absence of prong-like processes from its sides.

Formation and Locality.—The type of this species was obtained by Col. Grant, near the base of the " cherty-bed" at the Jolly-cut, Hamilton, Ontario, in the Niagara dolomite.

INOCAULIS CERVICORNIS, nov. sp.

Plate 5. Fig. 5.

Frond consisting of stipes having a common origin, and rising above into a few stout, widely extended, bifurcating branches, averaging from 1.5 to 2 mm. in breadth, and terminating in dichotomous points of equal thickness; texture corneous. with a striated surface.

Owing to the striations the appearance of the surface is that of rough scales or fibres, somewhat resembling the exterior portion of *I. plumulosus*. In the growing state, the branches appear to have been strengthened by longitudinal fibres — solid corrugations—and the cells to have been arranged vertically between them. A portion of the branches show a solid central axis, with a common canal surrounding it. The general arrangement of the branches resembles that of the horns of the American elk.

The typical specimen consists of six principal stipes, each about three centimetres long, with only a few branches. These stipes are united by a common runner (in the botanical sense), so that the whole organism is five centimetres broad, and three centimetres high.

Formation and Locality.—This rare and beautiful species occurs in the shaly dolomites of the "blue building-beds" of the Niagara formation at the "Jolly-cut," Hamilton, Ontario.

Inocaulis phycoides, nov. sp.

Plate 5. Figs. 6 & 7.

Stem flattened and from two to three millimetres broad; branches fastigiate, and originating on both sides of the principal stipe at frequent irregular intervals, and dividing near their terminations into two stout branchlets (from three-fourths to one and a half centimetres long), each ending in dichotomous free points. Texture corneous, with a surface apparently composed of scaly fibres.

Of this species, the fossils are not very well preserved. There is some indication of a central axis. This species is easily distinguished from *I. plumulosus* by the close, regularly arranged, parallel branches from each side of the principal stipes, and by their terminal branches. The fronds appear to have grown in groups, but whether they are connected at the base or not is unknown. If not connected, the individual fronds (in the specimens under consideration) are about four centimetres high and three broad, with from three to five principal branches on either side of the central stipe (the branches are more numerous on one side than the other). The character of the cellules is unknown.

Formation and Locality. — *Inccaulis phycoides* occurs in the dolomitic limestones of the Niagara formation, at the "Jolly-cut" quarries, Hamilton, Ontario.

Inocaulis ramulosus, nov. sp.

Plate 6. Fig. 1.

Frond consisting of numerous flattened bifurcating branches, originating in and radiating from a common radicle, composed of solid chitinous matter; branches averaging two millimetres in breadth for the larger, and one mm. for the smaller, towards the margin of the frond, where the branchlets end in two (sometimes three) extensions of unequal thickness. Texture corneous, with the surface composed of scaly fibres. Extending longitudinally through the stipes are central or subcentral elevations (sometimes depressions), indicating a solid central axis.

This species is described on two specimens, one of which shows the origin and base of the radiating branches, and the other the general frond, although the radicle is concealed. The extreme width of the typical specimen is fourteen centimetres, and the height eight centimetres.

In general form this species differs from *I. plumulosus* in that the branches are more slender, and rise regularly and more abundantly from the sides of the main stipes, which radiate from a common origin and do not consist of groups of individual fronds. The radicle appears to have been attached to some rocky surface in the sea, and not to have grown on some muddy bottom. The cell-bearing stipes appear to have had a common canal, through the centre of which was a central solid axis, as is also indicated in *I. cervicornis*.

Formation and Locality.—These specimens were obtained in the shaly dolomites, below the "chert-beds" of the Niagara formation, at the "Jolly-cut," Hamilton, Ont.

GENUS THAMNOGRAPTUS (Hall).

Gr. *thamnus*, a shrub; *grapho*, I write.

(Palæontology of New York, vol. iii, 1859.)

"Bodies consisting of straight or flexuous stipes (simple or conjoined at base?), with alternating and widely diverging branches; branches long, simple, or ramose, in the same manner as the stipe. Substance fibrous or striate; the main stipe and branches marked by a longitudinal central depressed line, indicating the axis. Cellules or serratures unknown."

In this genus I have placed two species—one described in 1878; the other, which is subject to variations—in the present paper. Probably, however, there are more species of this genus in the Niagara formation at Hamilton, Ontario.

THAMNOGRAPTUS BARTONENSIS (Spencer).

Plate 6. Figs. 4 & 5.

Thamnograptus bartonensis (Spencer), Can. Nat., vol. viii., No. 8, 1878.

Stipe single and broad, with lineal undulating branches, and having half the thickness of the stipe. The bases of the branches are nearly at right angles with the stipe, but afterward bend upward; these are from one to two centimeters apart, and there is usually a depression of considerable length on the side opposite to their place of attachment, and an expansion on the same side. The texture is corneous and black, and the surface nearly smooth, but with a strong medial depression half a millemetre wide (marking a central axis?) extends through the stipe, which is one and a half millimetres broad.

The specimens obtained are not entire. The branches are often widely separated, and are sometimes long and flexuous, extending for several centimetres in length. It sometimes happens that we obtain a long stipe which may be either a portion of the structure below the branches or a portion of a separate branch.

Formation and Locality. — This species occurs in the Niagara dolomites at Hamilton, Ontario.

THAMNOGRAPTUS(?) MULTIFORMIS, nov. sp.

Plate 6. Figs. 2 & 3.

Stipes simple, flexuous, and strong, usually divided into two (sometimes three) branches of equal thickness. From both the undivided and divided stipe a few short irregular branches originate at long unequal distances apart; and these may or may not end in two free points. The texture is corneous and black, with the surfaces somewhat striated and impressed with a medial line (indicating a central axis?). In occasional specimens of the same mode of branching, short spine-like processes, from one-half to one millimetre long and half a millimetre apart, probably indicate the position of the cellules on both sides of the branches.

There is considerable variation in the size of these organisms. The larger specimens are four or five centimeters long, and the stipes are usually about one millimetre thick; however, some of the specimens, that I have referred here, have not more than half that size. In the larger specimens the branches are usually about half a centimetre apart.

In the rocks of the Niagara formation numerous fragments of organism of the Graptolite Family occur. Vast numbers, consisting of thick broken stipes, often flexuous, with one or two branches, or those with dichotomous terminations, are found, and cannot be referred to any species described. Yet they so closely resemble the better specimens of this species that I have placed them here, although a further study might separate some of them from this species.

Formation and Locality.—Fragments of this species occur somewhat abundantly in the Niagara dolomitic rocks at Hamilton, Ontario.

GENUS PTILOGRAPTUS (Hall).

Gr. *ptilon*, a feather; *grapho*, I write.

(Canadian Organic Remains, decade 2, 1865.)

"Frond plant-like, rooted(?), simple, or branching. Branches and branchlets plumose, the pinnules rising alternately on opposite sides of the branches; celluliferous on one face only; branches cylindrical or flattened. Substance corneous, dense; apparently smooth exteriorly, or corrugated by compression, or during fossilization."

Of this genus, the following beautiful species is preserved in the rocks of the Niagara formation at Hamilton, Ontario:

PTILOGRAPTUS FOLIACEUS (Spencer).

Plate 6. Fig. 7.

Ptilograptus foliaceus (Spencer). Can. Nat., vol. viii., No. 8, 1878.

Frond bipinately branching. Slender branches plumose, with delicate pinnules rising alternately from the opposite sides of the branchlets. There are angular cell-openings on one side of the pinnules, whilst on the other there are indistinct corrugations. The substance is highly corneous.

There are usually three or four branches originating from near the same place on the short stipe, giving a lobed appearance to the frond. On these numerous parallel pinnules are situated on both sides of the axis (sometimes as many as sixteen, the branches being rather more than a centimetre long), and on the lower sides of these branchlets the cell-denticles occur. (There are two cells and two intercellular spaces in the length of a millimetre. The pinnules seldom exceed half a centimetre in length, and rise at very acute angles. The slender branchlets are about one-third of an inch thick. Even if the branches are separated, they are easily recognized by the pinnules being regularly arranged. The whole frond is never more than two centimetres wide.

This species bears a resemblance to *P. plumulosus* of the Quebec group, though much smaller and with fewer pinnules.

Formation and Locality.—This beatiful little fossil, one of the most perfectly preserved species of the group, occurs in the Niagara dolomites at Hamilton, Ontario.

GENUS CYCLOGRAPTUS, NOV. GEN.

Gr. *kuklos*, a disc; *grapho*, I write.

In this genus, the frond consists of a circular disc which was probably cup-shaped in its growing form, though flattened in a concave manner in the rock. From the radicle many stipes radiate through the non-celluliferous disc to its margin, and thence in a free manner to some distance beyond. The whole frond resembles a solid wheel, where the radiating spokes extend from the centre regularly to beyond the circumference. The branches beyond the disc are celluliferous. The stipes have a central solid axis. The substance is highly corneous, though in some places replaced by pyrites.

This genus somewhat resembles the discoid species of the *Graptolite Family* belonging to the Quebec group. Yet all the branches or stipes are short and relatively small compared with the disc, which is circular (when flattened). The general appearance of this genus is another example of the similarity of many of the more complex forms of graptolitic organisms which existed in the Quebec and Niagara periods, though so widely separated in point of time.

I had often noticed the wheel-like stains in several rocks found at Hamilton, but generally referred them to concretionary stains in the rocks. It was only in December, 1879, that I obtained two specimens and two casts whose characters could be determined. All of these specimens belong to one species.

CYCLOGRAPTUS ROTADENTATUS, nov. sp.

Plate 6. Figs. 6 & 6*a*.

Frond circular, with numerous stipes radiating from a common centre and projecting like a toothed wheel beyond the margin of a non-celluliferous disc. The frond was probably cup-shaped when growing, with the stipes projecting upwards like a row of spines or of tentacles, but in the rock the fossil is flattened and slightly convex. The stipes originate in the centre, and are connected about half their length by their continuous non-celluliferous membrane. Each stipes after passing beyond their solid disc divide into two branches about half way between their extremities and the margin of the disc. The branches or stipes are traversed by a central cylindrical, smooth, solid axis surrounded by their common canal, which is sometimes only represented by a central depression or elevation, but occasionally its form is well preserved. The rarely-indicated cell-openings are represented by minute oval depressions in the substance. The texture is highly corneous (or replaced by pyrites).

The diameter of the frond is two centimetres, and of the disc one centimetre; the radiating branches extend half a centimetre beyond the disc, and number between twenty-five and thirty, but, as each is divided, the frond is surrounded by about sixty points. The branches (both through the disc and free portion) are rather over half a millimetre broad, but the terminals are scarcely more than half that thickness and end in sharp points.

Formation and Locality. — This perfect little species was found in the dolomite of the Niagara formation proper, near the base of the series, at the quarry just west of the "Jolly-cut road," at Hamilton, Ontario.

PART II.

STROMATOPORIDÆ OF THE UPPER SILURIAN SYSTEM.

After the Graptolites of the Niagara formation there are, perhaps, no more interesting fossils than the Stromatoporidæ. Of this Family, six species (of which four are new) are found at Hamilton, Ontario, and one new species at Dalhousie (on the Ristigouche river), New Brunswick, all of which are herein decribed and figured.

The following is a list of these species:

Stromatopora concentrica (Goldfuss),
Caunopora walkeri (Spencer),
" *mirabilis* (Spencer),
Cœnostoma constellatum (Hall),
" *ristigouchense* (Spencer),
" *botryoideum* (Spencer),
Dictyostoma reticulatum (Spencer).

Besides these species, there are found in the Upper Silurian system the following species:

Stromatopora hendei (Nicholson),
" *osteolata* (Nicholson),
Caunopora hudsonica (Dawson),
Dictyostoma undulatum (Nicholson),
Cœnostoma galtense (Dawson).

GENUS STROMATOPORA (Goldfuss).

The characters of this genus, proposed by Goldfuss in 1826, and followed by DeBlainville and Lonsdale a few years later, are not sufficiently specific to include all the forms that have been placed under the name *Stromatopora*. Some have regarded the *Stromatoporidæ* as a natural group, others as a heterogeneous mixture. At any rate, these fossils have been a cause of much discussion as to their zoölogical affinities: they have been placed amongst *Sponges*, *Foraminifera*, and even *Corals*. The two prevailing opinions refer them to either *Foraminifera* or *Sponges*. It is not my purpose to discuss this subject, but to point out several forms that occur at Hamilton, in the Niagara formation. These remains characterize various formations from the Upper Cambrian to the Devonian inclusive; and probably they still existed in the later Carboniferous period, as indicated by some forms found in Missouri.—Many forms occur in Canada, ranging from the Niagara to the Corniferous groups. Those Niagara forms occurring at Hamilton must be referred to several genera or subgenera. They all consist of laminæ, which were originally calcareous (in some cases the calcareous matter has been replaced by silica), deposited concentrically on some foreign surface (or around some centre), separated by interspaces through which delicate pillars extend, connecting the lamellar surfaces. The laminæ are connected by minute pores giving communication between the interlaminar spaces. Sometimes these pores connect more distant interlaminar spaces by passing through hollow pillars. Again, the laminæ may be pierced by horizontal or oblique tubes. The surfaces of the mass often show irregular comparatively large apertures, indicating perforations extending through several interspaces; but these last, as remarked by Dr. J. W. Dawson, are lined with dense matter, as exhibited in some of the Niagara species. Even though the laminæ are mammillated or nodulose in form, the vertical section always appears as stratified layers of more or less rectangular cells, even though the spaces may be partly filled by the thickening of the walls.

Those who regard *Stromatopora* as allied to *Sponges* consider the laminæ and pillars as calcareous spicules cemented, and the larger tubes as *oscula*—this last structure being the principal reason for placing them with Sponges. The presence of spicules is very doubtful. Principal Dawson states that he has detected no spicules, and found that the larger perforations did not extend to the true surface, besides being surrounded by a strong case. This latter structure (the cased tubes) he regards as accidental or as some coral like Syringopora, perforating the mass. If thess forms be true Sponges, then the pores through the laminæ are inhalant pores for the animal, and the larger and more scattered tubes are exhalant *oscula*. In some species these larger tubes do not occur over the surfaces of even larger size. If the weight of the evidence is in favor of their alliance with Foraminifera, as it appears to be, then the interlaminar spaces and the minute tubes were filled with animal matter. The nearest analogues of more modern times are the *Loftusia* and *Parkeria* (of Carpenter, Brady, and G. M. Dawson), which are described as gigantic arenaceous *Foraminifera*. Of these two genera, Dr. G. M. Dawson has obtained one species in British Columbia as old as the Carboniferous period.

As noticed above, the large tubes do not occur in some specimens even though of many square inches surface. Yet there are other species where their occurrence is almost too regular to be regarded as accidental.

We will now notice briefly those Niagara species at Hamilton.

STROMATOPORA CONCENTRICA (Goldfuss, 1826).

Plate 6. Figs. 8 & 8*a*, enlarged.

In the Clinton and lower portions of the Niagara beds at Hamilton we find spheroidal or irregular masses made up of coneentric laminæ sometimes surrounding some foreign nucleus, or with a crystalline interior. Always there is a more or less concretionary appearance on the exterior surface. The laminæ are connected by pillars. The rectangular spaces are sometimes almost filled or even obliterated by the thickening of the walls. No further structure than the relative sizes of the cells and laminæ (which are without undulations) is apparent, owing to the crystalline and compact structure of the limstone, which, about the organism, is often silicified. It is highly probable that this Niagara form is referrible to *S. concentrica*.

GENUS CAUNOPORA (Phillips, 1841).

"The typical species is 'amorphous,' composed of concentric or nearly plane masses perforated by flexuous or vermiform small tubuli and by larger straight subparallel or radiating open tubes, persistent through the mass. This definition includes those species with simple tubes giving origin to radiating tubuli passing through the thickened laminæ."

Such is the description of this genus as defined by Dr. Dawson in the Quarterly Journal of the Geological Society (Feb., 1879). As that distinguished geologist also remarks, the specimens both of this genus and *Cœnostoma* (Winchell, 1867) bear much closer analogies to Sponges than those of the typical *Stromatopora*, "as the vertical tubes may be taken for *oscula*, and the extremities of the fine tubes as incurvent pores." But the "solidity of the calcareous walls and the supplemental thickening are at variance with such views." In the paper from which the above is quoted, the author has been obliged to reverse the generic names "*Caunopora*" and "*Cœnostoma*" as used by Hall.

To this genus, *Caunopora*—at least two species of organisms belonging to the Upper Silurian system—should be placed.

CAUNOPORA WALKERI, nov. sp.

Plate 6. Figs. 9 & 9*a*.

Parasitic, incrusting other bodies (in this case *Favosites*, in a hemispherical form thinning out at margins) to a depth of two centimetres. Laminæ thin and obscure with chambers entirely filled with supplemental matter, only occasionally traversed by short tortuous horizontal canaliculi, connected with the vertical tubes. Vertical pillars connecting laminæ removed or obscured by the filling, but with numerous connecting pores apparent and filled with matter different from that of the rest of the mass.

The organism is traversed by irregularly situated vertical tubes producing orifices on the surface of about one-half millimetre diameter, and scattered over the surface at from 2 to 4 mm. apart. In some places these seem to be surrounded by walls. The connecting pores are crowded together and are apparently situated around centres or sometimes around the larger tubes themselves, and do not exceed a tenth of a millimetre in diameter. These pores extend down into the substance and sometimes appear to traverse several thicknesses of laminæ, and in a vertical section as many as five pores with intervening four spaces occurring in the length of one millimetre. The individual plates are scarcely distinguishable, as generally two or more are soldered by the supplemental filling, so that the individual laminæ are not separable more than at from one-half to two millimetres apart; but the vertical pores, through this dense matter, being filled by differently colored matter, are conspicuous through the several layers. The surface is too much worn to show any structures except when polished.

In the specimens that I have seen, the original matter is all silicified. The specimen on which this description is based is about the fourth part of a reef, fifteen centimeters in diameter, given to the writer by Mr. A. E. Walker of Hamilton, who obtained it from one of the lower beds of the Niagara formation at that city. This species bears a close resemblance to *C. hudsonica* of Dawson, but differs in its rudimentary horizontal canal system and the arrangement of the pores. There is also a resemblance to the Devonian *C. incrustans* of Hall, but besides the radiating canals there appears to be an absence of pustules around the apertures on the surface.

CAUNOPORA MIRABILIS, nov. sp.

Plate 6. Figs. 10, 10*a* & 10*b*.

This organism has a hemispherical discoid form. Like other species of the *Stromatoporidæ*, it consists of a mass of concentric laminæ with their interspaces. These laminæ are traversed by the numerous pores which come to the surface. Besides these there are two systems of tubes perforating the whole thickness. The smaller of these two series has a diameter of about half a millimetre, and are situated at from 2 to 4 mm. apart, and radiate more or less from the centre of growth. These are lined with strong calcareous walls. The other series consist of not numerous vermiform calcareous tubes of larger size, at least more than a millimetre or even two millimetres in diameter. These last originate in the surface of a hemispherical calcareous nucleus, around which the different laminæ have grown, and extend through the whole reef to beyond its surface. This last is a most striking feature. The nucleus, referred to, has a diameter of more than 1.5 centimetres, but the fracture shows the vermiform structure to extend into its substance as well as the smallest pores. On the lower side of the fractured laminæ, the smaller tubes appear to be filled by hemispherical tabulæ. The vertical section shows about two laminæ and two interlaminar spaces in a millimetre thickness. A considerable portion of the typical reef was probably obtained, and has a diameter of about eight centimetres.

Besides the above description, it may be remarked that the horizontal canaliculi are scarcely apparent. The specimen is much silicified, and weathered so as to make visible the laminæ, pores, and tubes. In places, however, where the organism is not weathered, the supplemental filling of the spaces obscures the laminæ themselves.

The general appearance closely resembles *C. walkeri*, but it can be distinguished by the peculiar large vermiform tubes originating from its own nucleus, and by not being a parasite. Only one specimen has been obtained from the Niagara formation at Hamilton, so far as I am aware.

Genus CŒNOSTOMA (Winchell, 1867).

The real distinctive character of this genus, as stated in Dr. Dawson's memoir on "Structure of Stromatoporidæ" (Q. G. S., 1879), is the "absence of central simple radiating tubes, which in these species are represented by a group of more or less divergent ascending tubuli, so that the surface of the last layer presents eminences not with a single large pore at summit, but with several small pores diverging from their sides."

Cœnostoma constellatum (Hall).

Plate 6. Fig. 11.

"Massive, hemispheric, spheroidal, or irregular; composed of thin concentric layers which are penetrated by minute vertical tubes or cells; surface of layers nodulose, each elevation being marked by an irregular stellate impression with undulating and bifurcating rays; intermediate spaces smooth, or only having minute cell-apertures."

In this species, those specimens obtained at Hamilton have their laminæ much thinner than the spaces, there being two of each for every millimetre in thickness. The spaces have been completely filled with supplemental matter. It is exceptional to find specimens showing the nodulose surface, but numerous specimens exhibit beautifully the stellate impressions of the horizontal canaliculi when the surfaces are polished.

Formation and Locality. — The habitat of this species is in the uppermost two feet of the Niagara-beds, exposed at Carpenter's limekiln, two and a half miles south of Hamilton, Ont., where it is abundantly found associated with *C. botryoideum* making up a great portion of the bed of limestone ; but the organism is always highly mineralized with dolomitic grains. This horizon is near the top of the Niagara series.

Cœnostoma ristigouchense, nov. sp.

Plate 6. Fig. 12 (natural surface) and 12*a* (enlarged vertical section).

Large reefs composed of concentric layers penetrated by minute vertical tubuli, ending in the fine rounded granules of the surface ; the connecting bars of the tubuli situated about as far apart as their diameters, producing the appearance of horizontal pores situated one above the other. Masses vertical, penetrated by undefined canals, sending off many radiating canaliculi, thus producing on the surface irregular depressions, bifurcating and radiating among the papillar terminations of tubuli. These undefined vertical canals are situated about one centimetre apart, and in the same distance there will be found irregular rows of the nodulose ends of twenty-five or thirty tubuli, in the centre of each of which there is a depression. The thickness of the layers is from 1 to 2.8 millimetres (where there is a tendency for the stone to split horizontally), but in this distance there are from three to eight horizontal cross-bars (between the tubuli), and the intervening spaces of about the same size.

The surface appearance resembles *C. constellatum*, but the stellated canaliculi are much larger. Also, the ends of the tubuli (shown on the surface) are much larger than in *C. constellatum*, and arranged often in undulating rows of perforated papillæ. There are no pores other than the tubuli.

Formation and Locality.—This beautiful organism forms reefs of two or three feet diameter in a fossiliferous limestone of the Upper Silurian (Lower Helderberg probably) system, on the bank of the Ristigouche river, at Dalhousie, New Brunswick.

Cœnostoma botryoideum, nov. sp.

Plate 6. Fig. 13, general view: 13*a*, section of surface, nat. size; 13*b*, vert. sec. enlarged.

These fossils form hemispherical masses of considerable size. In some places the bed-rock is almost entirely composed of masses of these species, together with *C. constellatum*, varying in size from a few centimetres to a few decimetres in diameter, irregularly thrown together. This species is composed of concentric laminæ arranged in a botryoidal manner. These hemispherical undulations do not often exceed two (or rarely three) centimetres in diameter. The surfaces of the laminæ are smooth, without any papillæ, and the laminæ themselves when broken can be removed like the coats of an onion. Sometimes these botryoidal masses so undulate that upon the different individuals there is a graceful depression resembling the osculum of the sponge, *Oculo-copina;* but this depression does not communicate with the interior of the laminæ. The laminæ are very thin, and, with the interlaminar spaces, about three pair occur in the thickness of a millemetre. These are connected by pillars, leaving nearly square spaces or cells. In the specimens obtained, the fossils are so mineralized that the spaces have been filled, and subsequently the original calcareous laminæ and pillars have been removed, leaving what, in the fossil, forms the cells. These cells (generally filled), which originally were the pores, extend through the laminæ and crowd the surface with minute circular pores. Besides these pores, we find that the mass is traversed by the divergent tubuli characteristic of this genus. These are less than half a millimetre in diameter and open on the smooth surface, where they are indicated by apertures on the summit, or on the sides of the mammillated nodules, deposited irregularly at from four to eight millimetres apart.

This species does not appear to bear any structural relation to *S. osteolata* (of Nicholson), belonging to the Guelph group, although it is mammillated somewhat similarly, and in a horizon not very much below those beds. It may be remarked that in a hemispherical nodule of two centimetres diameter the height is rather more than half that distance. Differing from that Guelph species, the laminæ appear to be arranged around imaginary centres. The surface is also free from the papillæ of Prof. Nicholson's species, and besides we have moderately frequent tubes opening irregularly over the surface either at the summit or sides of the nodulose masses. Besides this, the pores on the surface of the laminæ are apparent under the microscope, as their mineral filling is somewhat differently colored from that of the rest of the organism.

The mineral matter is composed lergely of dolomitic grains, which, owing to the porous character of the organism, crumbles easily.

Formation and Locality.—It occurs in the upper Niagara beds at Carpenter's limekilns, about two and a half miles south of Hamilton, Ontario.

GENUS DICTYOSTOMA (Nicholson, 1875).

In this genus the fossils are composed of undulating concentric layers surrounding imaginary centres. These layers are traversed by horizontal canals. From the upper surfaces of the laminæ conical points are developed which support the laminæ above (in place of pillars) without being amalgamated with them. The exterior surface is apparently solid, except irregular rounded perforations which extend into the mass more or less vertically.

DICTYOSTOMA RETICULATUM, nov. sp.

Plate 6. Figs. 14 & 14*a* (enlarged vertical section).

This fossil is composed of concentric laminæ, which, with the interlaminar spaces, have a thickness of rather more than one millimetre for every pair, each being about half that thickness. On the edges there appear the mouths of horizontal canals traversing the layers. From the upper surfaces of the layers numerous hollow conical points or elongated processes extend to the lower side of next layers, without being united with them. There are about three of these points in every millimetre of length. Besides these connections between the laminæ, there are occasional strong vertical pillars, at about every two centimetres apart, that only extends from one layer to the next. In some specimens, this last laminar support is wanting; and in that case the specimens so closely resemble Prof. Nicholson's description of *D. undulatum*, from the Niagara formation of Kentucky, as to differ only in the relative sizes of the masses, layers, and conical point.

The general form of those specimens that I have seen are irregular masses not more than four or five centimetres long. They are generally highly silicified and occur in cherty nodules, not infrequently associated with Sponges; but the layers and points are generally of a different color from the filling of the rest of the organism.

Formation and Locality.—It occurs in the "cherty-beds" of the Niagara formation at Hamilton, Ontario.

NOTE. — In the Upper Silurian rocks of America, besides the above described species of *Stromatoporidæ, Caunopora hudsonica* (Dawson), is from the Upper Silurian south of Hudson's Bay, discovered by Dr. Robert Bell (Assistant Director of the Geological Survey of Canada); *Dictyostoma undulatum* (Nicholson), was collected by the Rev. H. Hertzer in the Niagara formation of Louisville, Kentucky: *Stromatopora osteolata* (Nicholson), was obtained by Mr. John Wilkie in the Guelph formation, at Guelph, Ontario; and *Cœnostoma galtense* (Dawson) is from the Guelph formation at Galt, Ontario. *Stromatopora hindei* (Nicholson) was obtained in the Niagara rocks at Rockwood and Owen Sound, Ont.

PART III.

FIFTEEN NEW SPECIES OF NIAGARA FOSSILS.

At Hamilton, Ontario, nearly two hundred species of fossils belonging to the Niagara series have been found, but only after a long and faithful search, for the conditions of preservation are not very favorable. (See "Geology of the Region about the Western End of Lake Ontario," by the writer, in Canadian Naturalist, Montreal, 1882.)

Besides the *Graptolitidæ* and *Stromatoporidæ*, already described, there are several species of Sponges which have not yet been fully studied. There are various other new species of fossils, of which I venture upon the description of the fifteen following species, several of them being both remarkable and interesting:

Palæaster granti, n. s.
Fenestella bicornis, n. s.
Polypora (*Fenestella?*) *albionensis*, n. s.
Rhinopora venosa, n. s.
Clathropora(?) *gracilis*, n. s.

Lingula ingens, n. s.
Discina clara, n. s.
Crania anna, n. s.
Pleurotomaria clipeiformis, n. s.
Conularia magnifica (Spencer, 1879).
Conularia rugosa, n. s.
Conularia wilkinsi, n. s.
Orthoceras bartonense, n. s.
Cyrtoceras reversum, n. s.
Lituites niagarensis, n. s.

PALÆASTER GRANTI, nov. sp.

Plate 7. Fig. 1.

Body stellate and small with short arms, about two centimetres across; disc less than one centimetre wide, and apparently formed by the junction of the rays; rays five millimetres wide at base, tapering slowly, and terminating in rounded extremities, at about eight millimetres from junction of their base with the disc; upper surface of rays composed of five ranges of highly convex or tuberculiform plates (the marginal and ventral rows being the most conspicuous) and separated from each other by minute plates (becoming fewer on approaching the extremities of the rays.

The ellipsoid marginal tuberculiform plates number about twelve for each complete side of the rays, and the central range is composed of a similar number, but in form these plates are more circular. The disc between the terminal central row of plates of the rays is crushed and structureless, except a slight elevation in the centre. The terminal plates of the marginal series are larger than the others of the range. The madreporiform tubercle is of a spherical form and relatively large, being nearly two millimetres in diameter, and is situated at the axil of two rays. Both the tuberculiform plates and the madreporiform tubercle have a horny granulated surface.

The ventral side is unknown. Only two specimens have been obtained, and of the more perfect two rays are broken away, although the whole of the disc is present.

This elegant species is easily distinguished from both *P. niagarensis* and *Petraster bellulus* by the relatively short arms, and smaller number of radial plates, although the upper sides of these species are unknown.

Formation and Locality. — This species was discovered by Col. C. C. Grant in the upper Clinton-beds at Hamilton, Ontario.

RHINOPORA VENOSA, nov. sp.

Plate 7. Fig. 3.

Frond, consisting of a calcareous crust, expanded over the surface of several centimetres area. The surface is crowded with rounded cells, raised into conspicuous papillæ and arranged in diagonal rows. The whole frond is strengthened by a strong system of bifurcating rounded network of veins, which is itself marked with oval cells. Veins are about one millimetre in diameter, and situated several times that distance apart, with about 24 oval cells in the length of a centimetre. The papillose cells are one-third of a millimetre in diameter, and the rows of these cells are separated by depressions one-fourth of a millemetre in width.

Formation and Locality.—It occurs in the shaly-calcareous Clinton rocks at Hamilton, Ontario.

CLATHROPORA(?) GRACILIS, nov. sp.

Plate 7. Fig. 4.*

Stems cylindrical below, enlarging rapidly above, and dividing into two or four flattened branches; frond apparently poriferous on both sides; apertures of cells more or less quadrangular, rhomboidal or oblong, and arrranged in series parallel to the direction of the stems, and near the base in quincunx order. This species resembles fragments of *Clathopora alcicornis*, but differs from it in that the stem tapers to a minute base, and in the character of the pores, which are very minute, there being longitudinally about three in the length of a millimetre, and transversely about five rows with their separating linear ridges in the same measurement. The largest specimen obtained measures three centimetres from base to broken summit (divided into two branches at about one centimetre from base), and three millimetres at greatest breadth of branch.

Formation and Locality.—This species is found associated with fragments of Trilobites in the earthy blue dolomites just below the "chert-beds" of the Niagara formation, at Hamilton, Ontario.

FENESTELLA BICORNIS, nov. sp.

Plate 7. Fig. 2.

Frond long and slender, consisting of a single stipe, making two nearly equal divisions about midway between base and sum-

* Fig. 4 is not a good representative of the markings.

mit. Margins of frond rounded, with the surface covered by about nine fenestrules in its breadth, in the branches, and twelve below the bifurcation. Fenestrules subrectangular, and much longer than broad; and separated by the comparatively stout celluliferous portions of the frond, connected by very delicate cross-bars. Porous structure not well defined, having been obliterated in the crystallization of the limestone. Length of frond, nine centimetres, and breadth from 1.5 to 2 millimetres. The general appearance is like a bundle of fine threads lying close together and connected transversely by finer cross-threads.

Of this beautiful species only one specimen has been obtained, and its general form is quite distinct.

Formation and Locality.—This specimen was obtained from the calcareous beds of the Clinton rocks at Hamilton.

POLYPORA (FENESTELLA?) ALBIONENSIS, nov. sp.

Plate 7. Fig. 5 & 5*a*.

Frond both flabellate and cyathiform on the stone, but always funnel-shaped in growing state. Branches rounded and mostly originating near the base, and dividing but a few times, with slight divergence, and extending to the margin without dichotomous terminations. Branches rather farther apart than their thickness, and connected by very slight transverse bars, situated more or less regularly at two or three times as far apart as the branches. Fenestrules oblong-subquadrangular or subrhomboidal. Branches circular in growing state, and longitudinally striated with the surface indicating more than two rows of pores imperfectly preserved.

The branches are about a quarter of a millimetre broad, and separated by rather more than that distance, with cross-bars about one millimetre distant from each other. From the base to the summit of the frond the measurement is two and a half centimetres, and the diameter of the circular frond double that distance.

This species closely resembles *Polypora inceps*, with branches more slender, and the transverse filaments not expanded at junction with branches, as in that species, producing a somewhat oval fenestrule, whose transverse to longitudinal diameters are as about 4 to 7, while in this species they are as 1 to 3 or 4.

Formation and Locality.—This exceedingly beautiful species is found high up in the series of the Niagara formation, in the shaly limestones occurring along the Rosseau creek, near Mt. Albion, six miles east of Hamilton.

NOTE.—In mode of branching and arrangement of cross-bars this species more nearly resembles those of *Dictyonema* than any Bryozoön that I have seen. But the absence of corneous matter, of solid axis, and the graptolitic cellules, are at once noticeable.

LINGULA INGENS, nov. sp.

Plate 8. Fig. 6.

Shell subelliptical and large, with sides nearly parallel, and converging with a gentle convex slope to the beak, at an angle a little less than ninety degrees, with apex rounded, the sides converging below in a circular form. Width of shell two-thirds the length. Surface smooth, glistening, and marked with numerous very fine, slightly diverging longitudinal striæ.

A narrow, shallow, concave sinus extends from the apex to near the base of one valve. The surface is also marked with infrequent concentric interruptions of growth which become more numerous and take the form of striæ near the margins, and bend back towards the beak. The length is 35 and the width 23 millimetres.

Formation and Locality.—This fossil was obtained by Col. Grant from the "chert-bed" of the Niagara formation at Hamilton, Ont.

DISCINA CLARA, nov. sp.

Plate 8. Figs. 5 & 5*a*.

Shell circular, both valves more or less conical with apex central or nearly so. The peduncular groove (on lower valve) strong, with nearly parallel sides, extending from the centre to half the distance to the margin; upper valve with surface unbroken. Both valves are marked by fine concentric striæ which increase in strength as they approach the margin (the central portion appearing smooth except under a lens). The grooves are much wider than the ridges. The interior of shell is nearly smooth, being only slightly marked by faint lines corresponding to the ridges on the exterior side. The upper valves are usually a littler smaller than the lower, the largest ventral valves being two centimetres in di ameter, and the peduncular sinus from three to four millimetres long,

This species resembles the British *D. forbesii*, but that species has the apex of lower valve eccentric. It has a closer resemblance to the Trenton species *D. circe*, but the peduncular groove in that species is acutely oval and the striæ extend farther into the shell. Mr. Billings, several years ago, placed a label on a species from Hamilton, *D. formosa*. From memory, it appears to have been this speeies, but he never described such a name; and consequently, in case this species does not stand, I have called it *C. clara*.

Formation and Locality.—It is a common Niagara species at "Jolly-cut road," Hamilton, Ontario.

CRANIA ANNA, nov. sp.

Plate 8. Fig. 4.

Shell small suborbicular, broader than long; dorsal valve convex, showing faintly the lamellar lines of growth, and strongly the sharp elevated radiating striæ; apex of dorsal valve subcentral and prominent.

Of this species three specimens are known. In breadth, they measure from seven to nine millimetres, with a height of about two-thirds that measurement. Only the convex limpet-like dorsal valve is known.

Formation and Locality. — This species was found in the "chert-beds" of the Niagara formation at Hamilton, Ontario, by Col. Grant.

PLEUROTOMARIA CLIPEIFORMIS, nov. sp.

Plate 7. Figs. 6 & 6*a*.

This shell is flattened-suborbicular in form, with four volutions, of which the inmost is indistinct. The whole are slightly convex with rounded margins, that above overlapping the one beneath. The whorls increase in breadth as they approach the surface, the inner being half a centimetre and the outer one centimetre wide. The diameter of the shell is about five centimetres. This shell is only known as a cast, with a nearly smooth surface.

Formation and Locality.—This fossil was obtained from Mr. Edward McLaughlin, and is from the upper beds of the Niagara limestones near Hamilton, Ont.

CONULARIA MAGNIFICA (Spencer).

Plate 9. Fig. 1; Figs. 1*a* & 1*b*, outer and inner surface, enlarged.

Conularia magnifica (Spencer), Can. Nat., vol. ix., No. 1, 1879.

Shell large, broad, pyramidal; marginal angles with shallow channels; each side marked with an inconspicuous medial depression; transverse striæ very fine, and closely arranged in a direction nearly direct from the marginal angle on one side to the medial depression, and thence (slighly bending) to the angular margin of the shell on the other ; transverse ridges crossed by fine closely arranged longitudinal ridges, producing fine rectangular papillæ Exterior portions of shell smoother than the interior, with the striations less conspicuous. In some places, the striæ are more crowded together than in others, but this may arise from compression in the rock.

This species differs from *Conularia niagarensis* in that it is very much larger ; and both the longitudinal and transverse striæ are relatively very much smaller, more numerous, and less curved : the medial depression is less distinct ; the longitudinal grooves are deeper though not so broad ; and, in particular, the grooves of the inner surface are not marked by conspicuous punctures.

The entire length of the shell is twenty-one centimetres with the apex broken off, but, if it were angular in place of rounded, the shell would measure three centimetres longer. At the broadest end, the extreme width of the side is thirteen centimetres, with portions of two adjacent sides crushed There are from 20 to 30 transverse striæ in the length of a centimetre, and from 30 to 40 longitudinal grooves in the same distance.

Formation and Locality.—Of this species only two larger specimens have been found (and one or two fragments). These were obtained from the "chert-bed" at the Jolly-cut road at Hamilton, Ontario, in 1872, by Mr. Yeomans, the superintendent of the quarries. One of these specimens now belongs to the Museum of McGill University and the other is in my own collection.

Of this species I published a notice in the Canadian Naturalist of Montreal in 1879, but the fuller description has been delayed to the present. Since finding these specimens in 1872, I have never seen any that have been subsequently obtained, although Col. Grant has observed one or two fragments. Although this species is so rare, *Cornularia niagarensis* is not uncommon, and of this latter species even large specimens have been found, one of which, comparatively large, and many smaller, have been in my possession.

CONULARIA RUGOSA, nov. sp.

Plates 8 & 9. Fig. 2; 2*a* is surface enlarged.

Shell large, and broad, pyramidal ; medial depression on side scarcely apparent, but producing an abrupt bending of the striæ. Surface of shell removed, showing only the internal cast. Broad, flattened, transverse ridges, separated by narrow deep channels, cross the sides of the shell and bend abruptly at medial lines. These are again traversed by shallow longitudinal striæ situated closer together than the transverse ridges, but which do not penetrate them to a depth of the separating transverse grooves. But, where the longitudinal striæ cross the transverse channels, there are punctures in the grooves; and where they cross the ridges, there is a depression in the centre of the ridges.

I have only seen one specimen, which is not entire. The fragment is 13 centimetres long, with two sides partly remaining; the greatest width at base of side (visible) is about five centimetres. In some places the shell is crushed, bringing the ridges and grooves together very closely in a wrinkled manner; and, where not crushed, the surface presents a wrinkled appearance. There are ten transverse ridges and furrows in one centimetre of length. The longitudinal striæ and the punctures in the transverse grooves are situated one-half millemetre apart.

Formation and Locality — This species was obtained in the Niagara limestone at Hamilton, Ontario, and presented to me by Mr. Tumbull of that city.

Conularia wilkinsi, nov. sp.

Plate 8. Fig. 3.

Shell short, broad, pyramidal; each side marked with an inconspicuous medial depression; transverse striæ very fine and arranged in a direction from edge to edge of valve, but bending at a considerable angle away from the apex in the region of the medial depression; punctures in the shallow striæ of interior surface of shell present, but indistinct.

This shell is usually as broad, or broader, than long. Length is usually between two and three centimetres. There are from 30 to 40 transverse striæ in every centimetre of length. Never more than two adjacent valves of shell are exposed.

Formation and Locality. — Niagara limestone at Hamilton, Ontario.

Orthoceras bartonense.

Plate 7. Fig. 7.

This shell is cylindrical, small, and tapering very slightly. The siphuncle is apparently subcentral. The surface is strongly annulated, and the crests are somewhat angular and situated at about 2.5 millimetres apart. The annular crests are marked by swelling waves (giving a nodular appearance on the margin), whose centres are closer than the distances between the crests of the rings. The surface of the shell is slightly striated parallel with the wave-like markings just mentioned. The calcareous matter is partly preserved, but only a portion of shell about five centimetres long was obtained. Its diameter is about one centimetre.

Formation and Locality.—This species occurs in the "chert bed" of the Niagara formation at Hamilton, Ont.

CYRTOCERAS REVERSUM, nov. sp.

Plate 7. Fig. 8.

Only the internal cast of this species is known. Its form is rapidly tapering, with a considerable curvature, until it ends in a rounded point. The surface is smooth, barely indicating the position of the septæ, which are about equal in length to the diameter of the shell at that place. The convex side of the septæ is directed towards the body-chamber. The siphuncle is unknown. Only the smaller end of this species is known; with the largest chamber, having a diameter of 1.25 centimetres, from which to the pointed extremity there is a distance of about four centimetres.

Formation and Locality.—It occurs in the lower beds of the Niagara limestones at Limehouse Station on G. T. R.

LITUITES NIAGARENSIS.

Plate 7. Fig. 9.

Tube large, and consisting of about two whorls when complete; section circular(?); siphuncle unknown; septæ concave, and numerous. The inner extremity of shell is unknown. The first whorl has a diameter of about 3.5 centimeters. After the completion of about one and a half whorls, the exterior whorl begins to separate, until, at the completion of the second turn, it is three centimetres distant, near which it terminates. The whole spire is about twelve centimetres across, and the diameter of the largest end of tube is not less than four centimetres (but it is much obscured). The diameter of the shell in the first whorl is rather more than one centimetre. There are about five very concave septæ in the length of two centimetres in the middle portion of the shell. The exterior surface appears to have been nearly smooth.

Formation and Locality.—Only one specimen has been obtained, and that was presented to the writer by Col. Grant. It occurs in the Niagara limestone at Hamilton, Ont.

Missouri Geological Surveys.

HISTORICAL MEMOIR

By G. C. Broadhead.

In the year 1849 the Missouri Historical and Philosophical Society authorized a committee, consisting of Falkland H. Martin, Sol. D. Caruthers, Samuel T. Glover, Wm. G. Minor, and De Witt C. Ballou, to present a memorial to the Legislature. This was presented to the 15th General Assembly of Missouri, and setting forth the advantages to be derived from a geological survey of the State and urgently asking liberal appropriations therefor. In their memorial they stated, in detail, what should be required in connection with such surveys, making it incumbent to show by descriptions and maps all the varied features of surface configuration; to investigate the causes affecting health; the agricultural capacity of the various soils; to describe the water-courses and water-powers; to analyze the waters of the springs, and to give full descriptions of the rock formations and analyses of minerals.

There have been two general geological surveys of the State of Missouri.

FIRST SURVEY.

Organized in 1853, under the direction of Prof. George C. Swallow. Continued in active operation until June, 1861.

SECOND SURVEY.

Survey prosecuted under direction of a Mining Bureau, organized in 1870. Discontinued in April, 1875.

THIRD PERIOD.

The control of property of the survey passed over to the School of Mines with a very small appropriation, which ceased after 1877 A.D.

FIRST GEOLOGICAL SURVEY.

April 12th, 1853, Prof. G. C. Swallow—recently of the State of Maine, where he had been engaged in teaching, and who was originally a pupil of Prof. Cleveland—received his commission as State Geologist. Prof. A. Litton, of St. Louis, was appointed Chemist, and R. B. Price, of Brunswick, Mo., Draftsman of the Surveys. Dr. Litton was then and has been nearly ever since Professor of Chemistry in two colleges in St. Louis. He was also previously employed by D. D. Owen as one of his principal assistants in the geological survey of Wisconsin, Iowa and Minnesota.

Subsequently B. F. Shumard, M.D.—then of Louisville, Ky., and a native of Pennsylvania—was appointed Palæontologist and Assistant Geologist. Dr. S. had previously occupied the position of Assistant Geologist to David Dale Owen in his survey of Wisconsin, Iowa and Minnesota.

During May and June, 1853, Prof. Swallow made surveys in the counties of Howard and Boone. In June Dr. Litton visited important mines in Southeast Missouri and made valuable collections therefrom. He worked two months in the laboratory, and later in the season he took the field, and, in company with Dr. Shumard, made special examinations of certain mines in Franklin, Washington, St. François, Madison, Jefferson, St. Genevieve and Perry counties. Dr. Swallow studied the geological structure along the Missouri river from the extreme north-west to Rochport.

In 1854, Maj. F. Hawn, then Assistant Engineer of the Hannibal & St. Jo. Railroad, made a geological section along the line of said road across the State.

In July, 1854, F. B. Meek, of Owensboro, Ky., was commissioned Assistant Geologist. He had previously been connected with the geological survey of Wisconsin, Iowa and Minnesota.

Prof. Swallow, in his first report, informs us that his aim had been to make out—

1. An outline of the Geology of the whole State.
2. A general view of the Mineral Wealth of the Mining Districts.
3. Exposition of the Agricultural and Manufacturing Resources of the State.
4. Reports, in detail, of as many Counties as possible.

In his second annual report, 1854, Prof. S. informs us that he and his assistants had

constructed twelve geological sections across the State in different directions in order to obtain an outline of the geological structure of the State.

In 1857 Garland C. Broadhead and Henry Engelmann were appointed Assistant State Geologists. Mr. E. was employed one year on the survey, assisting Dr. Shumard; G. C. Broadhead was employed for four years, until the termination of the survey in 1861. G. C. B. was a native of Virginia, but raised in Missouri: he studied geology, natural science and civil engineering at the University of Missouri and the Western Military Institute, Ky.; and had for his instructor Prof. E. Leffingwell, and at the Military Institute his instructors were Prof. Richard Owen (a brother of David Dale Owen), Geologist and Chemist, and Col. (afterwards Gen.) Bushrod R. Johnson and Col. Williamson, Professors of Mathematics and Engineering. Previously to being attached to the Missouri Geol. Survey, G. C. B. was employed for five years as a Civil Engineer. During 1857 Warwick Hough, recently Judge of Supreme Court of Missouri, assisted Dr. Shumard in his geological surveys.

In 1858 Dr. J. G. Norwood was appointed Assistant Geologist. Dr. N. had previously been principal assistant to Dr. D. D. Owen in the survey of Wisconsin, Iowa and Minnesota; he had also been State Geologist of Illinois, and had been several times professor in medical colleges; he was a native of Kentucky, and had been educated at Lexington and Louisville. Mr. Edwin Harrison, of St. Louis, assisted Dr. N. on his surveys in 1858; he has since been extensively engaged in mining and the manufacture of iron. He was a pupil of Agassiz.

In 1858 Dr. Shumard resigned his position on the Missouri Survey and accepted a position as State Geologist of Texas.

Mr. R. B. Price also resigued his position in 1858.

In 1858 P. C. Swallow and Daniel Crosby were employed as assistants on the survey.

P. C. Swallow was employed until 1861.

H. A. Ulffers was appointed Draftsman in place of R. B. Price, and was also Assistant Geologist until 1861.

Dr. Norwood was appointed Prof. of Chemistry in the Missouri University, and Dr. John Locke, of Cincinnati, Ohio, was appointed Assistant Geologist in his place.

Mr. C. Gilbert Wheeler, of Chicago, Ills., a very thorough chemist, was Assistant Geologist during 1860 and part of 1861.

The CHARACTER of the work of the first survey was mainly preliminary. Its aim was to mark down on accurate maps the boundaries of the geological formations, the limits of prairie and timber, mineral localities, and all other matters necessary to form a geographical as well as geological map. Sections were correlated and grouped; minerals, fossils, rocks, ores, and mineral waters collected, also the different kinds of soil. The bluffs along the streams were indicated upon the maps, the height of hills measured above the plains, but no strictly topographical snrveys were made. Such surveys as we have described were made in all except thirty-three counties.

Partial surveys were also made in other counties.

The survey was sustained by regular annual appropriations made by order of the Legislature.

The office and headquarters were in rooms of the State University at Columbia.

Although Prof. Swallow was during part of this time Professor in the University, the University had no control over the Survey or its officers, either directly or indirectly.

Besides paying special attention to geology, the members of the Survey were also requested, when convenient, to make botanical collections, also collections in zoölogy and the various departments of natural history, and to obtain all the necessary information towards constructing complete geological as well as geographical maps.

The chief assistants were appointed and commissioned by the Governor upon the recommendation of the State Geologist.

The State Geologist received $3,000 per annum, the Assistants from $1,000 to $1,500 per year.

There were generally two parties in the field, who camped out in tents, the camp equipage, horses, etc., being the property of the State.

The civil war of 1861 interfered with the progress of the survey, and it was stopped.

About the year 1866 the Legislature authorized Prof. Swallow and L. D. Morse to publish the manuscripts of the geological survey, but on account of the expense it was abandoned.

SECOND GEOLOGICAL SURVEY.

In 1870 the Missouri Legislature passed an act organizing a Mining Bureau, to be composed of the Governor and nine members, one from each congressional district. Under that law Albert D. Hager, of Vermont, was appointed by the Board as State Geologist, and the headquarters of the Survey established in St. Louis. Prof. Hager had been connected with the Vermont Survey and associated with Prof. Hitchcock.

Mr. Hager published one report of progress (21 pp.), briefly noticing the chief building-stones and minerals of the State. He also made partial examinations in several portions of the State, but no complete surveys. He held the position of State Geologist until August, 1871.

On the 18th March, 1871, the Legislature amended the law and made the Board to consist of four members besides the Governor.

Dr. Jos. G. Norwood was temporarily placed in charge of the Survey from Sept. 1st, 1871, until Nov. 25th, 1871. With Dr. Norwood, G. C. Broadhead was appointed Assistant Geologist and C. M. Litton sub-assistant.

The Board of Managers of the Survey were elected for two years; the State Geologist for an indefinite period, as long as the work would be well done. The State Geologist was authorized to appoint one Assistant Geologist and one Chemist, and such other assistants as the Board might deem necessary.

The bill authorizing the survey was in many respects similar to that of the first survey. Specimens were to be collected in triplicate, and reports of progress and financial statements were to be made to each General Assembly.

The Board were only allowed their necessary travelling expenses and when attending meetings. They elected a Secretary, who preserved the regular minutes, and received $50 per month salary. All accounts were to be made under oath, and filed with the State Auditor. The State Geologist and his assistants were required, before entering upon their duties, to make oath faithfully to perform their duties, and not to allow anyone to have access to their notes, nor to disclose to anyone or make public any information concerning mines or valuable deposits other than in their official reports (except to the owners thereof), and to abstain from all speculations in their behalf, or in behalf of others, during the progress of the survey. [A similar oath was also required of the members of the first Survey.]

The organization of the Survey in 1872 was—

Gov. B. Gratz Brown, *ex officio President of the Board.*

Edwin Harrison,	Forest Shepherd,
Prof. Sylvester Waterhouse,	Gen. J. H. Hammond.

Prof. Waterhouse and Gen. Hammond resigned in 1872, and their places were filled by A. W. Myers, of Linn, and L. A. Brown, of Howard.

Gov. Silas Woodson was President in 1873; Andrew A. Blair was appointed Secretary of the Board.

The corps of Geologists were—

State Geologist, Raphael Pumpelly.

ASSISTANTS.

G. C. Broadhead,	Dr. Adolph Schmidt,
Regis Chauvenet, *Chemist*,	W. E. Guy,
W. B. Potter,	C. J. Norwood,
J. R. Gage,	Alex. Leonhard.

Other sub-assistants were—John Pumpelly, in eharge of triangulation of Iron county; P. N. Moore, magnetic observer; F. Tunica, topographer; C. Gaylor, B. Vitzhum V. Eckstadt, draftsmen; also, T. J. Caldwell and T. A. Minor.

Of the *personnel* we would say that R. Pumpelly was a native of New York, a graduate of Freiburg, Professor in Harvard College, and at one time employed by the Governments of Japan and China in geological investigations. Dr. A. Schmidt was also a graduate of Freiburg, in charge of important works in Germany, since then in charge of Bessemer steel works at Troy, New York [he is now Professor in Heidelburgh, Germany]. R. Chauvenet, educated at Washington University, St. Louis, and was a student of Dr. A. Litton. Wm. B. Potter, educated at Columbia College, New York, was assistant on Ohio geological survey; is at present Professor of Mining and Metallurgy at Washington University, and Mining Engineer of the Iron Mountain, Mo., and is distinguished as a mining engineer and assayer. J. R. Gage, W- E. Guy and Alex. Leonhard were also students at Freiburg. P. N. Moore was educated at Columbia College, New York, and has since been connected with the Kentucky Geological Survey, and is favorably known as a mining engineer. G. C. Broadhead had formerly been connected with Prof. Swallow in the first geological survey, and in 1868 was assistant on the Illinois survey. C. J. Norwood was a son of J. G. Norwood, and was afterwards connected with the Kentucky geological survey.

In the fall of 1871 G. C. Broadhead with C. M. Litton made surveys in Madison county, and later in the season examined the geological structure and working coal mines near the line of the Missouri Pacific railroad from Sedalia to Kansas City.

In 1872 G. C. Broadhead, assisted by C. J. Norwood, studied the general geology of Northwest Missouri, making vertical sections of Missouri river bluffs from Brunswick to the north-west corner of Missouri and for 80 miles east.

Prof. W. B. Potter, assisted by Alex. Leonhard, made a survey of Lincoln county.

Prof. Pumpelly and others made a topographical survey of Iron Mountain, Pilot Knob and vicinity, and carefully studied the relations of the porphyries and related rocks with the ore deposits.

Dr. Schmidt studied the distribution and mode of occurrence of the iron ores and iron metallurgy of the State.

In May, 1873, Prof. Pumpelly resigned, and in June G. C. Broadhead was appointed State Geologist.

The geological corps during 1873 were—

G. C. Broadhead, *State Geologist;*
Dr. A. Schmidt, *Assistant Geologist;*
Regis Chauvenet, *Chemist;*
Chs. J. Norwood. *Assistant Chemist.*
Alex. Leonhard, P. N. Moore, and H. H. West, *Assistants.*
T. J. Caldwell, in the office.
C. Henrich, *Topographer.*

During the latter part of 1873, Schmidt, Norwood, Caldwell, and West, were the only assistants employed.

In 1873 P. N. Moore made a special examination of the chief limonite deposits of South-east Missouri. J. R. Gage examined certain lead mines in South-east Missouri. Dr. Schmidt, assisted by Leonhard, made careful examinations of the lead districts of Newton and Jasper. Messrs. Leonhard and Henrich made a topographical survey of the Granby lead mines. G. C. Broadhead, assisted by C. J. Norwood and H. H. West, made surveys in Jasper, Cedar, Barton, Vernon, and Bates; and later in the season made surveys in Howard, Linn, Adair, and Sullivan.

In 1874 Dr. Schmidt made careful examinations of the lead deposits of Cole, Miller, Morgan, Moniteau, and Cooper. C. J. Norwood and H. H. West made surveys in Putnam, Schuyler, and part of Chariton. G. C. Broadhead made surveys in Cole and Madison, and generally directed the survey and prepared the reports for publication.

The surveys from 1872 to 1875 were specially directed towards noting matters of the greatest economic importance, and developed mines were carefully examined.

During the administration of Pumpelly and Broadhead the office of the Survey was in Washington University, St. Louis, and the collections were also placed there.

MISSOURI GEOLOGICAL SURVEY APPROPRIATIONS

By Act of the Legislature.

From 1853 to 1862	$105,000 00
1870 and 1871	12,500 00
Under Acts of 1872, 1873 and 1874	60,000 00
In 1876 and 1877, used by School of Mines	5,000 00
Printing, 1873	12,000 00
" 1876	1,500 00
Total	$196,000 00
Deduct unexpended appropriations	19,814 45
Total expended	$176,185 55

I do not know what it cost to print Prof. Swallow's report, but it may have been $20,000; if so, we have

Printing Swallow's Report, 1854	$ 20,000 00
" Report, 1855 to 1871	3,000 00
" Pumpelly, &c., 1873	9,000 00
" Broadhead, &c., 1874	7,320 00
" Williams' Report, 1876	1,500 00
Total	$ 40,820 00
Leaving for field work, salaries, and incidentals	$135,365 55
Total as above	176,185 55

PUBLICATIONS.

LIST AND ANALYSIS OF THEIR CONTENTS.

First Annual Report, 1853. This was only a Report of Progress.

Second Annual Report, 1854. Includes 38 pages Report of Progress; Part I., 207 pages; Part II., 240 pages. Printed at Jefferson City, 1855.

Part I. of Five Chapters.

Chap. 1.—Geology of Missouri, with descriptive and illustrated sections. In this the various groups are described and named.

Chap. 2.—Economical Geology and soils; area and thickness of coal: principal deposits of iron, lead, and zinc; with short notices of the then partially developed lead mines of South-west Missouri. The chapter also includes brief notices of other minerals, clays, and stone, and of the lumber and water-power of the State.

Chap. 3.—Report on Marion County. G. C. Swallow.

Chap. 4.—Report on Cooper County. "

Chap. 5.—Geology of South-west Missouri. "

Part II. of Swallow's Report includes

Report of Dr. A. Litton on lead mines and mining of South-east Missouri, in the counties of Franklin, Jefferson, Washington, St. François, and Madison. This report describes the mode of occurrence of the (lead) ores, analyses, product, and sketches, of some mines. It also includes a Preliminary Report on copper mines of Franklin, and of the most important iron mines of South-east Missouri, with 48 analyses of ores, rocks, &c.

F. B. Meek has a Report and Map of Moniteau County.

F. Hawn, Catalogue of Rocks and Section along Hannibal & St. Joseph railroad.

Dr. Shumard's Geological Section on the Mississippi river.

Dr. Shumard's Reports, with Maps of St. Louis and Franklin counties.

Dr. Shumard's Description of 48 new species of Fossils, with 3 Plates of the same. Four county maps are published with this report, also numerous plates and sections.

Third Report of Progress, 1856.

Fourth Report of Progress, 1859. 14 pages.

Fifth Report of Progress, 1860. 19 pages.

The last three mainly relate to the progress of the survey, with notices of a few salient facts of discovery.

Annual Report, 1871. A. D. Hager. 23 pages. Somewhat similar to the annual reports of Prof. Swallow.

GEOLOGICAL REPORT, 1855–71. Jefferson City, 1873. 323 pages 8vo., with 3 colored photo-lithographs, plates, 8 county maps, index, and sections. 2,000 copies. The contents are

County Reports of Maries, Osage, Warren, Shelby, Macon, and Randolph, by G. C. Broadhead; Miller, Morgan, and Saline, by F. B. Meek; Ozark, Douglass, Wright, Laclede, Pulaski, Phelps, Crawford, Cape Girardeau, Perry, St. Genevieve, Jefferson, and Clark, by B. F. Shumard.

REPORT—IRON ORES AND COAL FIELDS—1873. Raphael Pumpelly, Director. 190 Illustrations, 2 Parts, and an Atlas. Part I., 214 pages; Part II., 440 pages. 2,000 copies. Printed and engraved by Julius Bien, New York. Contents:

Part I.

Chap. 1.—Geology of Pilot Knob and vicinity, by R. Pumpelly.

Chap. 2.—Analyses of fuels and iron ores, by Chauvenet and Blair.

Chaps. 3 to 6 inclusive, by A. Schmidt—Special description and distribution of deposits of iron ores.

Part II.

Chaps. 1 to 5.—Coal Measures of Missouri, by G. C. Broadhead.

Chap. 6.—Geological description and sections, near Mo. Pacific railroad, from Sedalia to Kansas City, by G. C. Broadhead.

Chaps. 7 and 8.—Geology of Lincoln county, by W. B. Potter.

Chaps. 9 to 15 inclusive, by G. C. Broadhead, with Reports on Livingston, Clay, Platte, Buchanan, Holt, Atchison, and Nodaway.

Appendix A.—Strength of building material. C. A. Smith.

" *B.*—Marbles of Missouri. G. C. Broadhead.

" *C.*—List of fossils. C. J. Norwood.

" *D.*—Depth of coal seams. G. C. Broadhead.

" *E.*—Tree map of North Missouri. G. C. Broadhead.

GEOLOGICAL SURVEY, 1874. G. C. BROADHEAD, *State Geologist.* 734 pages. 91 Illustrations in text, and Atlas, 14 Maps and Sections. Jefferson City, 1874. 4,000 copies. 35 chapters, 5 appendices.

Chap. 1 and Appendix A.—Early mining history.

Chap. 2.—General geology.

Chap. 3.—Caves and supply of water.

Chap. 4.—Soils, timber.

Chap. 5.—Minerals, rocks.

Chap. 6.—Topography of South-western Missouri coal field.

Chaps. 7, 8, 9, 10 and 12.—Geology of Cedar, Jasper, Barton, Vernon, and Howard, by G. C. Broadhead and Charles J. Norwood.

Chaps. 11, 13, 14, 15, 18, 19, 20 and 21.—Reports on Bates, Sullivan, Adair, Linn, Andrew, Daviess, and Cole, by G. C. Broadhead.

Chaps. 16 and 17.—On Putnam and Schuyler, by Ch. J. Norwood.

Chap. 21.—Madison county, by G. C. Broadhead and J. G. Norwood.

Chaps. 22 to 27.—Lead and zinc region of South-west Missouri, by Dr. Adolph Schmidt.

Chap. 28.—Mining and smelting of lead, by Dr. A. Schmidt.

Chaps. 29, 30, 31 and 32.—Lead region of Central Missouri, by Dr. A. Schmidt.

Chap. 33.—Practical rules for developing iron ore deposits, by Dr. A. Schmidt.

Chap. 34.—Lead region of South-east Missouri, by J. R. Gage.

Chap. 35.—Iron ores of South-east Missouri, by P. N. Moore.

Appendix A.—Notes on history of early mining in Missouri, by Henry Cobb.

Appendix B.—Lead mining of Upper Louisiana, by Moses Austin. Extract from American State Papers, 1804.

Appendix C.—Metalic statistics. From Merchants' Exchange Reports, 1872.

Appendix D.—Mineral springs of Missouri, by G. C. Broadhead.

Appendix E.—Chemical analyses, by R. Chauvenet.

REPORT OF CHAS. P. WILLIAMS on Metallurgy of Lead, Zinc, and Iron. 183 pages, 5,000 copies. Jefferson City, 1877.

Chap. 1.—Mineralogy and general metallurgy of lead, with analyses of galena.

Chap. 2.—Lead smelting.

Chap. 3.—Lead extraction; analysis and metallurgy of zinc; metallurgy of iron; geology of Shannon county; lead and zinc statistics.

DISTRIBUTION OF REPORTS.

The first Report of G. C. Swallow, 1854, was distributed through the members of the Legislature and the State Geologist.

The Reports 1855-71 and 1872, by authority of the Board of Mines and Geology, were distributed by the State Geologist, giving a certain number to each member of the Legislature and members of Congress, one to each county clerk's office in the State; certain others to literary, scientific and collegiate institutions in the State; and copies also to State libraries, scientific institutions and public libraries throughout the United States; certain number of copies also to the Geologist and his assistants for general distribution in this and foreign countries.

The Report of 1874 was distributed in part like the last, but more generally; the surplus copies were turned over to the State Geologist for general distribution. These were distributed to persons who by scientific repute could appreciate them, and copies were freely given to parties all over the United States, and were also sent into every civilized country on the globe.

COLLECTIONS.

Those of the first survey were all placed in the Missouri University. Under the law authorizing the survey, they were to be distributed proportionally to the Missouri University, Westminster College, and the Masonic College. The civil war interfering with the survey, the distribution was not made, and the specimens for the most part remained in boxes for 23 years, until 1884, when they were unpacked and partly arranged in the museum of the Missouri University. According to a rough calculation these may include about 50,000 specimens of all sizes. Under the laws governing the second geological survey, the specimens were to be distributed in the museums of the State University, the School of Mines, and Washington University. This was partly done in 1875; those not divided remain in the museum of Washington University arranged in cases.

The collections include many rare fossils, some as yet undetermined, and are very fully illustrative of the Palæozoic fauna of the Missouri rocks.

UNPUBLISHED WORK.

Much valuable work has been done which has never been written up, and probably one-half of the notes could not be made available. This work extended over forty-three counties, which were chiefly partially examined during the period of the First Geological Survey. Of these, Prof. Swallow examined the counties of Boone, Callaway, Christian, Green, Lawrence, Mississippi, New Madrid, Pemiscot, Scotland, Scott, and Stoddard; Dr. Shumard surveyed Butler, Carter, Lewis, Reynolds, Ripley, Stoddard, and Wayne. Dr. Norwood surveyed the counties of Benton, Cass, Henry, Jackson, Johnson, Lafayette, Pettis, and St. Clair. G. C. Broadhead made surveys in Audrain, Caldwell, Callaway, DeKalb, Gentry, Grundy, Harrison, Knox, Lincoln, Mercer, Monroe, Pike, Montgomery, Ralls, and St. Charles. Dr. John Lucke, C. Gilbert Wheeler, and H. A. Ulffers, made surveys of Carroll, Chariton, Clinton, and Ray.

BENEFITS RESULTING FROM THE SURVEY.

There was but little known of Missouri geology prior to the First Survey of Prof. Swallow. Dr. King, Dr. Prout, Dr. Maughas, and others, had written short articles published in magazines or newspapers. In 1801 Moses Austin had published statistics and notes of the then known lead mines. In 1819 Schoolcraft had issued a similar publication, and Whitney published brief notices in his "Metallic Wealth."

The First Geological Survey of Missouri approximately indicated the area of our coal fields, defining the boundary thereof, and showed that there were three principal divisions, viz., the Upper, the Middle, and the Lower coal measures. It located many important coal mines, and stated where our principal known lead mines were. Dr. Litton's careful survey of the lead mines of South-east Missouri informed us of the mode of occurrence and manner of working the mines, and gave analyses of the lead.

Prof. Swallow correlated remote sections and classified the rock groups, so that the scientific world might know what formations existed in the State. His vertical section has not been materially changed since then. Some provisional names of groups have given place to others deemed more appropriate.

In the three series of the coal measures the geological surveys have shown that the Upper was mostly barren of coal, the Lower productive.

Broadhead's map of the coal fields, in Atlas of 1872, defines the line between the barren and productive coal measures. This was not previously known, and a glance at the map will at once indicate where coal might be profitably mined.

There are beds of black slate occurring at intervals in the coal measures, but there are other similar strata which are found in older formations which the Missouri survey demonstrated contained no coal. Careful studies of the Missouri coal measures also showed that its beds could be readily recognized by the organic remains peculiar to this group of rocks, until then but little known to the palæontologist.

Dr. Schmidt's iron ore map, in the Report for 1872, indicated by signs the proportional amount of iron in certain districts—very important to the prospector.

The Geological Report for 1874 particularly described certain coal districts, giving the depth, area, and approximate yield of coal which might be expected under certain areas. These counties have since shown a marked increase in population and coal mining operations. The Report of Bates Co. (by G. C. Broadhead) was reprinted in a "History and Gazetteer" of the county, and many extracts from it published in a circular which was published and widely circulated. The attention of railroad companies was directed towards this county and several roads built to the principal coal fields of Bates, Vernon and Barton counties. The result has been the building up of several railroad towns, including Rich Hill, which in three years grew to a town of 4,000 inhabitants, and the establishment of zinc works and other manufacturing establishments.

The geological survey has shown that petroleum existed in eight or nine counties of Western Missouri, but not in paying quantities. But large sums of money have previously been wasted in boring wells for oil where a geological knowledge would prove its uselessness. About six borings, from 500 to 800 feet deep, have been made in search of coal oil in Western Missouri, not to speak of many lesser ventures. It has been estimated that at least $20,000 has been thus uselessly spent; $100,000 has been thrown away in mining and erection of works for extraction of tin ore in Missouri, and over $100,000 spent in lead mining at one place, besides many useless expenditures at other places. Over $100,000 has been badly spent in silver mining in Missouri. All of these items, when footed up, count.

Much of this could have been saved by consultation with skilled geologists and conscientious mining engineers.

An owner of iron mines in Missouri said that if he had read Dr. Schmidt's report before beginning work he would have saved over $1,000.

An iron furnace was erected a few miles from the Osage near a certain iron bank. The ore there was soon exhausted (being a pocket), and any other ore would have to be hauled by team, or else boated down the river and hauled out to the furnace; whereas, if the furnace had been located at the river, it could be economically kept at work. It had to suspend operations.

Dr. Schmidt's Reports on the lead mines were accompanied with exact illustrations of the mode of occurrence and working of the mines.

In early mining in Missouri large quantities of zinc ore as well as carbonate of lead were thrown away as useless, but science has since saved many thousand pounds of ore.

On the Specific Heats, Specific Gravities, and the Heats of Hydration of the Acids of the Fatty Series, and their mixtures with Water.

By Dr. CHARLES LUEDEKING.

Chemical composition and physical properties are day by day shown to be more and more correlated, and so much so that the standpoint of scientists to-day in many departments of chemistry and physics has been solidly based on the tacit mutual understanding, that the differences of certain physical properties are but the expression of the difference in the chemical constitution, so that from this latter we may draw definite conclusions concerning the former and *vice versa*, although just in these latter times many of the rules formerly accepted as true have been shown to be erroneous. Where discrepancies occur and the universal law does not hold, we by no means abandon our general theorem, but consider that the discrepancy is due to complexity of conditions not fully understood, or that the theory from which we draw our conclusions is not yet fully developed, so that the constants we calculate have no definite physical meaning, as this is the case with the conception of molecular volume, etc.

Amongst substances that show irregularities in their corresponding physical properties we may count the lower members of the fatty acid series whose vapor densities are, for example, in a singular way anomalous.

It seemed to me that it would be desirable to study this series more thoroughly. I desired especially to determine whether or no the "gasogen" molecules of these acids $C_nH_{2n}O_2$ are united in the liquids to form complex "liquidogen" groups $(C_nH_{2n}O_2)_m$ that under certain conditions again split up into *m* molecules $C_nH_{2n}O_2$.

To advance a little to the solution of this question I determined the specific gravities, specific heats and heats of hydration of the first four members of the fatty acid series as well as of their mixtures with increasing equivalents of water.

The results obtained are always deduced at least from duplicates, and when these showed greater differences the number of determinations was augmented.

The only works in similar directions known to me were those of *Favre*, Compt. Rend. 50, p. 1150, "On the heats of hydration of acetic acid"; and of *Von Reiss*, Wied. Ann. x., p. 291, "*Eigenthümliche Beziehung zwischen Dichte und spec. Wärme der Gemische von Essigsäure und Wasser.*" I append the results of these authors for the sake of comparison. They differ from mine by amounts lying within the limits of error, as will be seen.

Previously to making the measurements appended below, my care was directed to insurance of pure materials. The acids used were of Kahlbaum's manufacture. Before experimenting on any of them they were dehydrated by rectification from calcium-chloride and redistillation of the distillate so obtained. In regard to boiling point, specific gravity, and specific heats, they were found to agree very closely with the results obtained by other observers, as will be seen by referring to the data given below. Therefore I am warranted in the conclusion that they were pure.

The mixtures of the acids with water were made by weighing out each constituent on a chemical balance giving the $\frac{1}{10}$ of a milligrame.

THE SPECIFIC GRAVITIES.

They were determined by means of a pycnometer with perforated stopper capable of holding 9.9812 grms. of water at 25° C. The measurements were made in the ordinary way at constant temperature for each series, which was accomplished by immersing the flask in a water-bath of constant temperature. The numbers obtained for the duplicates in each case were most concordant. The greatest differences amounted to a unit in the third place, and the average difference was about six in the fourth place. In each table the temperature at which the determinations were made is indicated. The specific gravities are reduced to the specific gravity of water of the same temperature and not to water of 4° C., as we need these numbers to calculate the condensations. The data given are the mean of duplicates. The first column, headed n, gives the number of equivalents of acid; the column headed n' gives the total number of equivalents of water added to one equivalent of acid; the column headed p gives the percentage of acid contained in the various mixtures; column S gives the specific gravity as found; column S' gives the specific gravity of the mixtures as calculated under the assumption that the constituents exercise no action upon one another, and enter with their original volumes into the mixture by the formula—

$$S' = \frac{wc + w'c'}{w + w'},$$

in which w and w' signify the weights used, and c and c' the specific gravities of the constituents. The column headed S/S' serves to show the progress of the condensation. In Fig. II. are given in a curve these values S/S' as ordinates, and the corresponding equivalents of water n added as abscissas.

Formic Acid.

The boiling point of the formic acid used was 100.3° corrected, and its solidification point 0°.

The determinations were made at 22° C.

n	n'	p	S	S'	S/S'
0	0	1.0	1.2182	1.2182	1.0000
½	½	83.6	1.1902	1.1825	1.0063
½	1	71.9	1.1650	1.1569	1.0070
½	1½	63.0	1.1456	1.1375	1.0071
½	2	56.1	1.1306	1.1224	1.0073
1	3	46.0	1.1076	1.1004	1.0065
1	4	38.9	1.0915	1.0850	1.0060
1	5	33.8	1.0799	1.0738	1.0057
1	6	29.9	1.0708	1.0652	1.0053
2	8	24.2	1.0565	1.0528	1.0035
2	10	20.3	1.0482	1.0444	1.0036
5	15	14.5	1.0348	1.0317	1.0030
5	20	11.3	1 0271	1.0247	1.0024
5	25	9.2	1.0224	1.0202	1.0019
5	30	7.8	1.0191	1.0171	1.0019
10	40	6.0	1.0145	1.0131	1.0014
10	50	4.8	1.0120	1.0106	1.0014
10	60	4.0	1.0102	1.0089	1.0013
10	70	3.5	1.0088	1.0077	1.0013
10	80	3.1	1.0078	1.0067	1.0011
10	90	2.8	1.0072	1.0060	1.0012

The figures as well as the curves show that the condensation rises very rapidly at first and then gradually attains a maximum, when the composition of the mixture corresponds nearly to the formula $CH_2O_2 + 3H_2O$, from whence on they gradually fall to the zero value of no condensation.

ACETIC ACID.

Determinations made at 22° C.

The boiling point of the acetic acid was 118.1° corrected.

p	n	n'	S	S'	S/S'
100.0	0	0	1.0465	1.0465	1.0000
86.9	½	½	1.0650	1.0404	1.0236
76.9	½	1	1.0677	1.0269	1.0311
69.0	½	1½	1.0662	1.0321	1.0331
62.5	½	2	1.0636	1.0291	1.0338
52.6	1	3	1.0571	1.0245	1.0318
45.4	1	4	1.0516	1.0211	1.0298
40.0	1	5	1.0482	1.0186	1.0290
35.7	1	6	1.0425	1.0166	1.0278
29.4	2	8	1.0340	1.0137	1.0201
25.0	2	10	1.0292	1.0116	1.0173
18.2	5	15	1.0246	1.0085	1.0160
14.3	5	20	1.0193	1.0066	1.0126
10.0	10	30	1.0113	1.0046	1.0066
7.7	10	40	1.0083	1.0036	1.0047
6.2	10	50	1.0051	1.0029	1.0022

The following are the results obtained by *Von Reiss*:

Per ct. Acid	S	S/S'	Per ct. Acid	S	S/S'
100.	1.0471	1.0148	56.	1.0600	1.0319
93.2	1.0604	1.0218	53.	1.0577	1.0313
87.8	1.0647	1.0243	50.	1.0555	1.0301
85.	1.0654	1.0267	47.	1.0536	1.0259
82.	1.0664	1.0300	38.	1.0452	1.0211
77.6	1.0677	1.0320	28.1	1.0323	1.0155
70.3	1.0666	1.0327	19.3	1.0245	1.0093
67.	1.0655	1.0326	10.8	1.0166	1.0045
64.5	1.0645	1.0328	5.4	1.0059	1.0023
62.	1.0634	1.0326	2.7	1.0020	—
59.	1.0618	1.0324	0.0	0.9982	—

It will be seen that the maximum of condensation takes place in the formation of the third hydrate, to which the curve gradually rises, and from whence it falls very precipitately at first, and then more slowly and gradually in its approach to the zero line of no condensation.

PROPIONIC ACID.

Determinations made at 25° C.

The boiling point of the propionic acid was 140.5° C. corrected.

p	n	n'	S	S'	S/S'
100.	0	0	0.9902	0.9902	1.0000
89.1	½	½	1.0077	0.9913	1.0166
80.4	½	1	1.0158	0.9921	1.0239
73.3	½	1½	1.0197	0.9928	1.0271
67.3	½	2	1.0212	0.9934	1.0280
57.8	1	3	1.0225	0.9943	1.0283
50.7	1	4	1.0250	0.9950	1.0301
45.1	1	5	1.0237	0.9955	1.0284
40.6	1	6	1.0234	0.9960	1.0275
33.9	2	8	1.0214	0.9966	1.0249
29.1	2	10	1.0195	0.9971	1.0225
21.5	5	15	1.0160	0.9978	1.0183
17.0	5	20	1.0143	0.9983	1.0161
14.1	5	25	1.0112	0.9986	1.0126
12.0	5	30	1.0095	0.9988	1.0107
10.5	5	35	1.0085	0.9990	1.0095
9.3	5	40	1.0075	0.9991	1.0084
8.3	5	45	1.0068	0.9992	1.0076
7.6	5	50	1.0069	0.9993	1.0076
6.4	10	60	1.0056	0.9994	1.0062
5.6	10	70	1.0048	0.9995	1.0053
4.8	10	80	1.0042	0.9995	1.0047
4.4	10	90	1.0038	0.9996	1.0042
3.9	10	100	1.0034	0.9996	1.0038
3.6	10	110	1.0033	0.9997	1.0036
3.3	10	120	1.0030	0.9997	1.0033

For propionic acid an inspection of the curve will show that its hydration is attended with a maximum of condensation at the fifth hydrate, from whence on the curve falls at first very rapidly and then more slowly in its approach to the zero line of no condensation.

Butyric Acid.

Determinations made at 25° C.

The boiling point of the butyric acid was 163.3° C. corrected.

p	n	n'	S	S'	S/S
100.	0	0	0.9549	0,9549	1.0000
90.7	½	½	0.9726	0.9591	1.0141
83.0	½	1	0.9809	0.9626	1.0190
76.5	½	1½	0.9853	0.9655	1.0205
70.9	½	2	0.9886	0.9680	1.0213
62.0	1	3	0.9938	0.9720	1.0224
55.0	1	4	0.9965	0.9752	1.0218
49.4	1	5	0.9987	0.9777	1.0215
44.9	1	6	1.0000	0.9797	1.0207
37.9	2	8	1.0020	0.9829	1.0194
32.8	2	10	1.0031	0.9852	1.0182
24.6	5	15	1.0045	0.9889	1.0188
19.6	5	20	1.0047	0.9911	1.0137
16.3	5	25	1.0046	0.9926	1.0121
14.0	5	30	1.0045	0.9936	1.0110
12.2	5	35	1.0045	0,9944	1.0102
10.9	5	40	1.0039	0.9951	1.0089
9.8	5	45	1.0037	0.9955	1.0082
8.1	10	55	1.0035	0.9963	1.0073
7.0	10	65	1.0029	0.9968	1.0062
6.1	10	75	1.0026	0.9972	1.0054
5.4	10	85	1.0022	0.9975	1.0047
4.9	10	95	1.0020	0.9978	1.0042
4.4	10	105	1.0019	0.9980	1.0038
4.1	10	115	1.0017	0.9982	1.0035

For butyric acid a maximum of condensation is found to take place in the formation of the fourth hydrate, from whence the curve gradually approaches the zero line of no condensation. The specific gravity of a mixture of butyric acid and water having the composition $C_4H_8O_2 + 6H_2O$ is 1,000. Mixtures containing less than this amount of water have specific gravities less than one, whilst those containing more than this amount have specific gravities greater than one. When the mixture has the composition $C_4H_8O_2 + 20H_2O$ the specific gravity is a maximum, being 1.0047.

COMPARISON OF THE CONDENSATIONS OF THE DIFFERENT ACIDS.

The similarity of these condensation curves is apparent. They all attain maximas, whereupon the curves more or less gradually fall to the zero line of no condensation. All four acids on the first additions of water show an increment in the specific gravity. This has long been known to be the case for acetic acid, whilst to my knowledge no similar experiments have been made for the other three acids.

I must state that the positions of these maximas are however not constant, but vary with the temperature.

For further instruction I have calculated the molecular condensations, which will be found in the following table. The column headed *n* gives the number of equivalents of water added to the acids designated at the heads of the other columns. Under each acid there are two columns, the first of which shows the molecular condensation of the acid under the assumption that the water molecules remain unchanged in volume, whilst the second gives the molecular condensation of the water molecule; that is to say, the total condensation divided by the number of water equivalents, under the assumption that the acid molecule remains unchanged.

n	Formic.		Acetic.		Propionic.		Butyric.	
	S_m	⊿	S_m	⊿	S_m	⊿	S_m	⊿
½	0.55	1.1	1.53	3.06	1.40	2.8	1.4	2.8
1	0.80	0.80	2.28	2.28	2.10	2.1	2.0	2.0
2	1.26	0.63	3.07	1.53	3.00	1.5	2.7	1.35
3	1.46	0.48	3.49	1.16	3.50	1.17	3.2	1.1
5	1.80	0.30	4.23	0.84	4.50	0.90	3.9	0.78
10	2.10	0.21	4.13	0.41	5.60	0.56	4.9	0.49

It is apparent from the table that the molecular condensation of the acids increases with increasing quantities of water, whilst the molecular condensation of the water decreases steadily under the above assumption. The condensations in case of acetic, propionic and butyric acids are very nearly equal to one another, and very much greater than for formic acid.

THE SPECIFIC HEATS.

For these determinations I used *Kopp's* method, as modified by *Bettendorf* and *Wüllner*. Pogg. Ann. cxxxiii.

My calorimeter was cylindrical, of the very thinnest brass, and could contain about 30 grms. of water. It was supported on three sharp metal pins inside of a water mantle, to avoid interference from foreign radiation and conduction. Its water value together with that of all accessories was 0.8 g. The water value of the test tube used to contain the liquids examined was 0.2124 g. The average quantity of substance used in the determinations was 5.6 g. The glass tube was held firmly clamped immersed in an oil bath, which was itself in turn immersed in a water bath. By this means the temperature was capable of being maintained very constant, so that the fluctuations of the temperature of the mercury amounted at most to several tenths of a degree during an hour. The temperature of the mercury bath was always about 50° C. The usual time of the immersions of the glass tube was 15 minutes. The temperature of both the mercury bath as well as the calorimeter could be determined to 0.01° C. with certainty. My thermometers were exceptionally concordant in their registrations. The corrections for influence of radiation, $\Sigma \Delta T$, were made by *Regnault's* method. To make them as small as possible the method of *Rumford* was adopted; the temperature of the calorimeter was regulated so that at the end of an experiment it stood as much above the temperature of the mantle as it was below it at the beginning. The temperatures of the calorimeter were recorded from 20 to 20 seconds.

The following is an estimate that I made of the maximum of error that could possibly occur in these determinations:

Special heat of substance	...		0.5229.	
Error in reading calorimeter	0.01°	sp. H. 0.5208	diff.	= 21
Error in $\Sigma \Delta T$	0.005°	" 0.5219	"	= 10
Error in reading mercury bath	0.1°	" 0.5248	"	= 19
Error in water value of calorimeter	0.1°	" 0.5210	"	= 19
Total error				69=1.1%

This, it must be remembered, is the maximum error.

In the following I give my results. The column headed n shows the number of equivalents of water added consecutively to one equivalent of the acid; the column under n' shows the total number of equivalents of water added; that headed P shows the percentage of acid in these various mixtures; the column headed

c gives the observed specific heat, while that headed c' gives the specific heat as calculated as a mean of the constituents; the column c/c' shows the amount of deviation from this calculated mean of the experimentally determined values.

To facilitate comparison I have appended in Fig. III. a curve for each acid in which the values c/c' are ordinates, whilst the values n' are abscissas.

Formic Acid.

Specific heat between 50° and 16°.

The formic acid used in these determinations was the same as that used above in the specific gravity determinations.

n	n'	P	c	c'	c/c'
0	0	100.	0.5360	0.5360	1.000
½	½	83.6	0.6689	0.6120	1.093
½	1	71.9	0.6962	0.6665	1.044
½	1½	63.0	0.7027	0.7076	0.9931
½	2	56.1	0.7207	0.7397	0.9743
1	3	46.0	0.7835	0.7866	0.9960
1	4	38.9	0.8078	0.8191	0.9862
1	5	33.8	0.8272	0.8430	0.9812
1	6	29.9	0.8464	0.8613	0.9827
2	8	24.2	0.8735	0.8877	0.9840
2	10	20.3	0.8907	0.9056	0.9836
5	15	14.5	0.9170	0.9324	0.9835
5	20	11.3	0.9322	0.9476	0.9838
10	30	7.8	0.9479	0.9636	0.9837
10	40	6.0	0.9600	0.9727	0.9869
10	50	4.8	0.9686	0.9774	0.9910

The figures and the curve show that the values c/c' increase very rapidly at first to a maximum corresponding to the formula $CH_2O_2 + \frac{1}{2}H_2O$. Then these values decrease very precipitately and reach a minimum at the third hydrate, when they again increase to reach a second smaller maximum at the fourth hydrate. At the sixth hydrate a second smaller minimum is reached, and from thence on the curve approaches the unit value of c/c' very gradually.

ACETIC ACID.

Specific heat between 50° and 20° C.

The acetic acid used was the same as that used in the specific gravity determination.

n	*n'*	*P*	*c*	*c'*	*c/c'*
0	0	100.	0.5118	0.5118	1.0000
½	½	86.9	0.5681	0.5755	0.9871
½	1	76.9	0.6414	0.6245	1.027
½	1½	69.	0.6785	0.6633	1.023
½	2	62.5	0.7136	0.6949	1.027
1	3	52.6	0.7736	0.7431	1.041
1	4	45.4	0.8061	0.7781	1.036
1	5	40.	0.8303	0.8047	1.032
1	6	35.7	0.8536	0.8256	1.034
2	8	29.4	0.8812	0.8564	1.029
2	10	25.0	0.9016	0.8789	1.027
5	15	18.2	0.9331	0.9112	1.024
5	20	14.3	0.9517	0.9303	1.023
10	30	10.0	0.9682	0.9511	1.018
10	40	7.7	0.9730	0.9624	1.011
10	50	2.2	0.9941	0.9695	1.015

The following numbers give the results of *M. A. von Reiss* on the specific heats of mixtures of acetic acid and water.

Per ct. Acid	*c*	*c'*	*c/c'*
93.2	0.5395	0.5455	0.989
87.8	0.5639	0.5721	0.989
85.0	0.5901	0.5829	1.007
82.0	0.6171	0.6008	1.027
77.6	0.6440	0.6226	1.034
70.3	0.6784	0.6586	1.031
67.0	0.6890	0.6749	1.021
64.5	0.6977	0.6872	1.016
62.0	0.7217	0.6996	1.032
59.0	0.7382	0.7144	1.034
56.0	0.7588	0.7292	1.040
53.0	0.7708	0.7441	1.036
50.0	0.7777	0.7588	1.025
47.0	9.7929	0.7737	1.024
38.0	0.8349	0.8182	1.021
28.1	0.8854	0.8661	1.022
19.3	0.9308	0.9106	1.022
10.8	0.9692	0.9527	1.017
5.4	0.9906	0.9793	1.011
2.7	0.9998	0.9926	1.007

The figures and the curve show that the values c/c' attain a minimum on addition of the first half equivalent of water. Then these values rapidly reach a maximum at the second hydrate. A slight minimum is then reached, to be followed by a second greater maximum at the fourth hydrate. At the sixth hydrate there seems to be another slight minimum. The values c/c' then gradually approach unity in value.

Propionic Acid.

Specific heat between 50° and 22° C.

The propionic acid used was the same as that used in the specific gravity determinations.

n	n'	P	c	c'	c/c'
0	0	100.	0.5227	0.5227	1.000
½	½	89.1	0.5924	0.5765	1.038
½	1	80.4	0.6732	0.6179	1.089
½	1½	73.3	0.6954	0.6520	1.066
½	2	67.3	0.7229	0.6805	1.062
1	3	57.8	0.7789	0.7254	1.074
1	4	50.7	0.8204	0.7592	1.081
1	5	45.1	0.8477	0.7857	1.080
1	6	40.6	0.8672	0.8069	1.075
2	8	33.9	0.8971	0.8388	1.070
2	10	29.1	0.9260	0.8616	1.074
5	15	21.5	0.9577	0.8978	1.067
5	20	17.0	0.9621	0.9190	1.047
10	30	12.0	0.9767	0.9427	1.036
10	40	9.3	0.9829	0.9557	1.028
10	50	7.6	0.9840	0.9639	1.021

The figures and the curve for propionic acid show that the values c/c' very abruptly reach a maximum at the second hydrate and then sink to a minimum at the fourth hydrate. A second maximum then follows at the sixth hydrate. At the tenth hydrate a second minimum seems to occur, followed by a slight increase, whereupon the values c/c' gradually approach unity.

Butyric Acid.

Specific heat between 50° and 23 C°.

The butyric acid used was the same as that used in the specific gravity determinations.

n	n'	P	c	c'	c/c'
0	0	100.	0.5032	0.5032	1.000
½	½	90.7	0.5785	0.5493	1.053
½	1	83.0	0.5878	0.5876	1.079
½	1½	76.5	0.6675	0.6198	1.077
½	2	70.9	0.6832	0.6475	1.055
1	3	62.0	0.7309	0.6921	1.056
1	4	55.0	0.7662	0.7268	1.054
1	5	49.4	0.7936	0.7544	1.052
1	6	44.9	0.8142	0.7769	1.048
2	8	37.9	0.8465	0.8116	1.043
2	10	32.8	0.8704	0.8369	1.040
5	15	24.6	0.9095	0.8779	1.036
5	20	19.6	0.9367	0.9024	1.038
10	30	14.0	0.9564	0.9304	1.028
10	40	10.9	0.9705	0.9459	1.026
10	50	9.5	0.9956	0.9554	1.026

For butyric acid the values c/c' and curve also reach their first maximum at the second hydrate. A slight minimum is to be observed at the third hydrate. The further course shows no marked deviations from gradual approach to unity.

COMPARISON OF THE VALUES c/c' FOR THE FOUR ACIDS.

Formic acid appears to differ very much from the other three at first sight. Closer inspection, however, will show that this is by no means the case. The increment of specific heat on addition of the first half molecule of water to formic acid is greater by far than for any of the other acids, as is also the increment in density. For acetic acid the circumstances are different. Its first maximum lies at the second hydrate, whilst that of formic acid lies at 1½ hydrate. At 2½ hydrate of acetic acid there occurs the first minimum, followed by a maximum at the fourth hydrate, and a second minimum at the sixth hydrate, in which respects it agrees exactly with formic acid. Propionic, as well as butyric acid, have their first maxima at the second hydrate just as acetic acid has. Their first minima, however, occur at their third hydrates; these are followed by maxima again at their fifth hydrates. Propionic acid seems to show another minimum at its eighth hydrate.

The absolute magnitudes of the deviations of the observed from the calculated specific heat is inversely to the molecular weights of the acids, greatest for formic, least for butyric acid. The smaller the molecular weight, the more nearly the first hydrates are the greatest deviations observed; thus for formic acid the first maximum lies nearest, and for butyric acid farthest from the starting point.

For further instruction I have calculated the molecular heats of several mixtures of each acid and water, and subtracted from these values the molecular heat of the water in them. The molecular heat is, as is well known, the product of molecular weight and specific heat. The values so obtained are laid down in the following table. The first column (n) shows the number of molecules of water in the mixtures; column m gives the molecular heat of the water in the mixtures; the other four columns are headed by the names of their respective acids. Each contains two subcolumns, of which the first gives the molecular heat s_m found, while the second gives the differences (Δ) between this and the molecular heat of the water in the mixture given in column m.

n	m Mol. heat Water.	Acid Formic.		Acid Acetic.		Ac. Propionic		Acid Butyric.	
		s_m	Δ	s_m	Δ	s_m	Δ	s_m	Δ
½	9	36.12	27.12	39.1	30.1	48.97	39.97	55.2	46.2
1	18	43.8	27.8	49.9	31.9	61.64	43.64	62.2	44.2
2	36	59.0	27.0	68.4	32.4	79.20	43.20	84.3	48.3
3	54	78.3	24.3	87.7	33.7	107.36	53.36	103.6	49.6
5	90	111.5	21.5	124.5	34.5	138.90	48.90	140.6	50.6
10	180	201.4	21.1	216.0	36.0	233.60	53.60	263.1	83.1

With increasing molecular weight these differences also increase, being least for formic acid and greatest for butyric acid. Whilst for acetie, propionic and butyric acids the values increase with the number of equivalents of water added, the reverse is the case for formic acid. Formic acid behaves exactly like salt solutions in this respect, while the other three resemble tartaric acid.

NOTE.

My first experiments in Leipzig were made by a very convenient and exact method devised by my honored Professor, G. Wiedemann. As this method has not hitherto been published, I asked and obtained permission of its author to describe it here.

The method is based on the following principle:—A known quantity of pure mercury, heated to a known temperature, is run into a known quantity of the liquid substance whose specific heat it is desired to determine, and whose initial and final temperatures are observed. Knowing the specific heat of mercury, we have thus all data for our determination.

Herewith I give the detail of the apparatus. By means of steam, generated in a boiler (see Fig. I.), the cast-iron vessel *A*, which contains the mercury, entirely surrounded by the brass mantle *B*, can be heated to a very constant temperature closely approaching 100° C. The brass mantle consists of a lid (*L*), which is first traversed by the steam, and which is perforated by canals to admit to the cast-iron vessel an iron stirrer and a thermometer. Thus the mercury can be stirred and its temperature very exactly determined. From the lid the steam passes to the lower part of the mantle *B* through tubing *a*, and then into a condenser. The cast-iron vessel is large enough to hold from 2 to 3 klgs. of pure mercury, which can be tapped by means of the stopcock *S*; below this stopcock there is a metal plate perforated by many small holes; by this means the mercury is tapped into the calorimeter in a shower and loses its heat almost instantly, at the same time stirring the liquid quite thoroughly. The losing of the heat during the fall is mostly avoided by the walls at *m* and *n*, that are part of the brass mantle. To screen the calorimeter from the radiation of the brass mantle the hollow circular brass plate *D*, traversed by water of the temperature of the room, is interposed. A little screen just below the opening is thrown aside automatically at the moment when the stopcock is turned. A vertical screen (*E*) preserves the calorimeter from the radiations before and after the experiment.

The method of procedure in an examination is the following: The mercury is first raised to the constant temperature by the steam, an operation requiring but a very short time. The calorimeter has weighed out in it the substance to be examined, and is then placed on cork supports within a mantle (*M*), which in turn rests on the slide *F*. Either a thermometer bent at right angles, or one inserted through the side of the calorimeter, may be used to register its temperature. After the mercury has attained its uniform temperature the slide carrying the calorimeter, whose temperature has just been noted, is rapidly pushed under the stop-cock of the vessel *A*, and in an instant a certain amount of mercury allowed to run in; whereupon it is at once immediately withdrawn, stirred for one or two seconds, and the temperature again noted. The whole of this entire operation requires at most ten seconds. Then the calorimeter is again weighed and the amount of mercury run in thus determined. It is apparent that all data for calculation of the specific heat of the substance in the calorimeter are then at hand.

A very remarkable feature of the method, which is principally adopted for liquids, is, that it is so rapid of execution—by far the most expeditious of any known. A single determination would require at most ten minutes. Nor are there any corrections for radiation to be made, since the mercury loses its heat almost instantly — a fact attributable to its excellent conducting power, as well as to the minute state of division in which it is showered into the calorimeter. Lastly, the method is also eminently useful because of its great accuracy, being but little, if any, inferior to the Kopp method as modified by Bettendorf and Wüllner. The method does not require much substance for a determination of specific heat. From 10 to 15 g. suffice, though much more may be taken. Since the substance experimented on changes its temperature but very little, the true specific heat between a very narrow range of temperature is obtained, which is an important feature. The calorimeter has usually the temperature of the surroundings.

The cast-iron vessel can hold mercury enough for very many determinations, and thus a great number may be made in rapid succession.*

HEATS OF HYDRATION.

Finally, I present the results of my determinations of the heats of hydration of the acids of this homologous series. These measurements were made by mixing water and acid, both of the same temperature, in calorimeters of gilt brass and platinum, and of

* The apparatus is constructed by Mr. E. Stöhrer of Leipzig.

capacities varying from 30 to 210 ccm. The temperatures were measured by the thermometers used in the determinations of specific heats: they were read to 0.01° C., and it will be apparent, that, in those cases where the changes of temperature were only slight, the error could amount to a considerable percentage of the total. The results obtained will be found in Tables I. and II., given below.

The determinations were made at 18° C.

In Table I. *n* signifies the consecutive additions of the different equivalents of water to one equivalent of acid. The number of calories thereby evolved is given in each case under each of the four acids heading their respective columns. I append also the results obtained by Favre for acetic acid. It will be seen that the coincidence is quite close.

For convenience sake I have laid out the values obtained in curves. In Fig. III. the ordinates represent the number of calories, positive or negative, above or below the zero line, while the number of equivalents of water added *n'* are the abscissas.

TABLE I.

Eq. Water. *n*.	Acid Formic.	Acid Acetic.	Favre's Results.	Acid Propionic.	Acid Butyric.
½	+ 95.4	—112.4	—105.3	— 304.3	—336.
½	+ 41.3	— 30.4	— 29.5	— 93.2	— 97.3
½	+ 5.1	— 17.0	— 16.6	— 29.8	— 51.9
½	+ 6.9	— 8.5	— 8.2	— 16.8	- 30.6
1	— 27.7	— 4.2	— 3.5	+ 1.0	— 2.2
1	— 21.3	+ 3.4	+ 3.5	+ 24.8	+ 2.6
1	— 16.3	+ 6.7	+ 5.9	+ 34.7	+ 3.6
1	— 14.8	+ 11.6	+ 11.2	+ 26.0	+ 8.4
2	— 15.6	+ 22.8	+ 23.4	+ 85.2	+ 40.7
2	— 15.8	+ 28.3	+ 27.4	+ 73.3	+ 35.2
5	— 14.9	+ 54.0	+ 54.7	+148.6	+ 66.8
5	— 11.6	+ 51.8	—	+106.4	+ 64.2
10	+ 84.5	+ 85.4	—	+151.9	+182.6
10	+ 74.6	+ 39.7	—	+ 94.9	+159.0
10	+ 61.8	+ 21.4	—	+ 29.0	+ 99.4

For *valerianic* acid I found the negative thermal effect resultant on its union with ½ equivalent of water to be —339 g. calories.

The courses of the curves, constructed as indicated above, show the thermal effects as they change for the different acids in the course of the dilution. Formic acid alone gives a positive thermal effect in the formation of its first hydrates. With decreasing molecular weight the negative thermal effects decrease in the formation of the first hydrates for the other three acids, so that for butyric acid the negative thermal effect resultant upon its union with ½ eq. water is greater than for propionic acid, and for this latter greater than for acetic acid.

It was, therefore, in accordance with my anticipation that I found the negative thermal effect, resultant upon the union of valerianic acid with ½ eq. of water, still greater than for butyric acid.

Formic acid, in that it unites with its first half equivalent of water with a positive thermal effect, does not behave at variance with our anticipations. We should expect that this thermal effect would be either very slightly negative, or even positive, from the observations on the other three acids. It may be a mere coincidence only, but it is a fact, that the difference in the heats of hydration for this first ½ eq. of water between formic and aeetic acids is nearly equal to the difference between the heats of hydration for aeetic and propionic acids, being approximately 200 calories. The curves of all four acids show perfect analogy after the dilution has gone on to a certain extent.

In Table II. I give the actual thermal effects, resultant on the union of one molecule of each of the four acids with various equivalents of water The column headed *n'* gives the number of equivalents of water which unite with one equivalent of acid, with evolution of the annexed number of gramm calories. This table is deduced from the previous one. In Fig. IV. will be found curves in which these calories are the ordinates, whilst the number of equivalents of water added are the abscissas.

TABLE II.

n'	Formic Acid.	Acetic Acid.	Propionic Acid.	Butyric Acid.
½	+ 95.4	—112.4	—304.3	—336.0
1	+136.7	—142.8	—397.5	—433.3
1½	+141.8	—159.8	—427.5	—485.2
2	+134.9	—168.3	—441.1	—518.8
3	+107.2	—172.5	—443.1	—518.0
4	+ 85.9	—169.1	—418.3	—515.4

n'	Formic Acid.	Acetic Acid.	Propionic Acid.	Butyric Acid.
5	+ 69.6	−162.4	−383.6	−511.8
6	+ 54.8	−150.8	−357.6	−503.4
8	+ 39.2	−128.0	−272.4	−462.7
10	+ 23.4	− 97.7	−199.1	−427.5
15	+ 8.5	− 45.7	− 50.5	−360.7
20	− 3.1	+ 6.1	+ 55.9	−296.5
30	+ 81.4	+ 91.5	+207.8	−113.9
40	−156.0	+131.2	+302.7	+ 45.1
50	+217.8	+152.6	+331.7	+144.5

It is noteworthy that formic acid only gives a negative thermal effect when uniting with 20 equivalents of water. Evidently the heat of hydration must be a compound factor, the resultant of two antagonistic thermal effects.

The other three acids are quite similar to one another. The thermal effects observed are first negative, then positive, in each instance. A glance at Fig. III. will show this similarity very nicely. Formic acid at first attains to a maximum positive thermal effect at the third hydrate; acetic, propionic and butyric acids attain to a maximum negative thermal effect at their fourth hydrates. All four curves, from these points on, approach the zero line of no thermal evolution more or less gradually, and then rise to positive thermal effects, in every instance. The higher the molecular weight, the lower the curve descends in the area of negative thermal effect.

GENERAL CONCLUSIONS.

We proposed to examine in this research whether or no there was any relationship to be found between certain of the physical properties of the four fatty acids—formic, acetic, propionic, and butyric—an inference that we should be led to draw from their belonging to the same chemical series.

In general the specific gravities, specific heats and heats of hydration have unequivocally been shown to be related when compared for the four acids. The effect of increasing molecular weight has been noticed everywhere in its action on the above physical properties. However, in the examination of the lower hydrates the differences were often such as to make us despair of drawing any analogy whatever. This is only what we should expect. We can most positively answer the question that we put to ourselves

Fig I

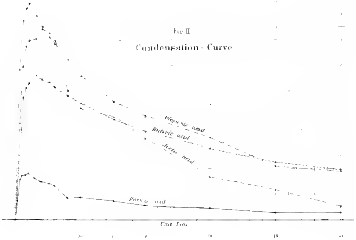


Fig II
Condensation - Curve

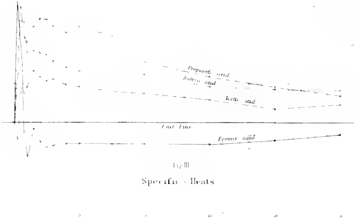


Fig III
Specific - Heats

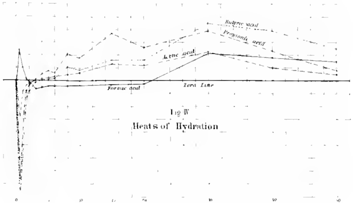


Fig IV
Heats of Hydration

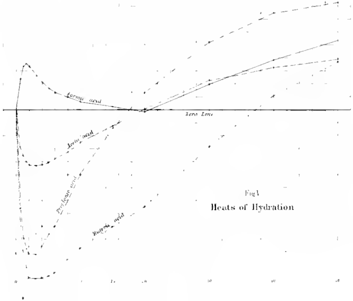


Fig V
Heats of Hydration

in our introduction, and say that the acids in the liquid form do most certainly consist of *m* molecules ($C_nH_{2n}O_2$), and further that this *m* must be different in value for the different acids. The negative heat observed in the formation of the first hydrates of acetic, propionic and butyric acids is due to nothing else than the dissociation of these complex molecules. As dilution of substance, especially in the gaseous state, is known to produce dissociation of complex molecules, so it is evidently with our fatty acids. Their complex molecules, which are the cause of their differences in the lower hydrates, become dissociated later on, and we then find perfect relative coincidence. We should expect the dissociation of the molecule of butyric acid to be attended with the greatest negative thermal effect, since it is so much nearer the solid state of matter, and in its case, therefore, the value of *m* is so much greater than for the others.

We should also expect that its actual heat of hydration, which is positive of course, is very much less than for any of the other acids, since its affinity for water must be less, becaure it lies so much nearer that class of acids which are actually fatty, and whose properties it therefore possesses in a degree superior to the other acids. Consequently all conditions concur to make the thermal effect more negative than for any of the others.

Even formic acid can now be understood in is differences from the others. It has the strongest affinity for water, and in its molecular complexity the value of *m* is less than for any of the others; consequently we have all the conditions at hand for a positive thermal effect in its first hydrations.

Complexity of experimental conditions, therefore, is the cause of our not observing absolute coincidence in the physical properties of the four acids that we have examined.

My especial thanks are due Professors G. and E. Wiedemann, at whose instigation these determinations were made, and who kindly gave me the benefit of their advice during the progress of this work.

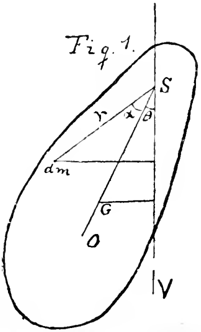
*Isodynamic Surfaces of the Compound Pendulum.**

By FRANCIS E. NIPHER.

In discussing the compound peudulum, the statement is sometimes made, that particles near and below the axis of suspension are retarded, and that those near the bottom of the pendulum are accelerated by reason of their connection with the system. The series of particles forming the axis of oscillation are neither accelerated or retarded.

In a general way, so far as it concerns the time of a complete oscillation, this is all true, but it is not true in any compound pendulum that the particles near the bottom continually exert a retarding effect upon the system. At any given instant certain particles in the system tend to diminish the actual acceleration, while others tend to increase it. These two tendencies always balance, although the value of each continually varies. These two groups of particles are separated by a surface, each particle of which has no tendency to change the acceleration of the system at that instant. The axis of oscillation always lies in this surface. On either side of this neutral surface there must be surfaces of equal tendency, those on one side having a plus, and those on the other side a minus sign. It is required to find the loci of these isodynamic surfaces at any given instant. This can be done by means of well known equations for the pendulum, which are first given.

In Fig. 1, let O represent the axis of oscillation, G the center of gravity, and S the axis of suspension. Call S G = K, S O = l, and let r be the distance of any element of mass dm from the axis S. Let θ = the angle V S O, and α the angle between the lines l and r, V S being the vertical plane containing the axis S.



The entire mass of the pendulum may be supposed condensed on the vertical plane passing through G, and at right angles to the axes O and S, each element of mass being supposed to be projected along

* Read Oct. 19th, 1885.

a line parallel to those axes. The pendulum then becomes a thin plate of varying density, lying in the plane of the paper as in Fig. 1.

This supposed condensation is really unnecessary in a rigid system, as the center of gravity G and the element *dm* may lie in different planes, at right angles to the axis S, without in any way changing the result.

At any instant the linear acceleration of O is $g \sin \theta$, and its angular acceleration is $\frac{g}{l} \sin \theta$. This is also the angular acceleration of every other particle in the system. The linear acceleration of *dm* is therefore $\frac{r}{l} g \sin \theta$. The force required to produce this acceleration on *dm* is

$$F' = dm \frac{r}{l} g \sin \theta.$$

The moment of this force about S is

$$F'r = dm \frac{r^2}{l} g \sin \theta. \qquad (1)$$

If the element *dm* were disconnected from the system, its linear acceleration in falling as a simple pendulum would be $g \sin (\theta + a)$, and the moment of the force required to produce this acceleration would be

$$F''r = dm\, rg \sin (\theta + a). \qquad (2)$$

Subtracting (1) from (2),

$$r(F''—F') = dm\, g\, r \sin (\theta + a) — dm \frac{r^2}{l} g \sin \theta. \quad (3)$$

The factor $F' — F' = d F$ is a force which must be impressed upon *dm* in excess of its tangential weight-component, in order to impart to the element its real acceleration at the given instant. This force may be either positive or negative, the sign depending upon the position of *dm* and the direction of swing.

The integral of (3) for the entire system is necessarily zero, or

$$\int dm\, g\, r \sin (\theta + a) — \frac{g}{l} \sin \theta \int dm\, r^2 = 0. \qquad (4)$$

The first term is the moment of the weight of the system, referred to the axis S in the plane VS; the second integral is the moment of inertia I, referred to the axis S: hence,

$$\mathrm{M}g\mathrm{K} \sin \theta - \frac{g}{l} \sin \theta \, \mathrm{I} = 0,$$

where M represents the entire mass of the pendulum. This gives the well known value of l.

$$l = \frac{\mathrm{I}}{\mathrm{M} \, . \, \mathrm{K}} \, .$$

The loci of the isodynamic lines in the disc pendulum are determined from (3), which may be put into the following form :

$$\frac{rd \, \mathrm{F}}{g \, dm} = r \sin (\theta + \alpha) - \frac{r^2}{l} \sin \theta. \tag{5}$$

This expression represents the moment of the impressed force $d\mathrm{F}$ per unit of weight at any point determined by the values r, θ, and α. Making this value constant, $= a$, it gives the condition for an isodynamic line, which is, therefore,

$$a = r \sin (\theta + \alpha) - \frac{r^2}{l} \sin \theta. \tag{6}$$

Let S be the origin of a system of rectangular coördinates, x being the horizontal and y the vertical coördinate of dm; then, as $r^2 = x^2 + y^2$ and $\sin (\theta + \alpha) = \frac{x}{r}$, equation (6) becomes

$$x^2 + y^2 - \frac{l}{\sin \theta} \, x + \frac{l}{\sin \theta} a = 0. \tag{7}$$

For a fixed value of θ, and a varying value of α, this is the equation of a series of concentric circles, the common center being on the horizontal through S at a distance $\pm \frac{1}{2} \frac{l}{\sin \theta}$ from S. The radius of any circle is

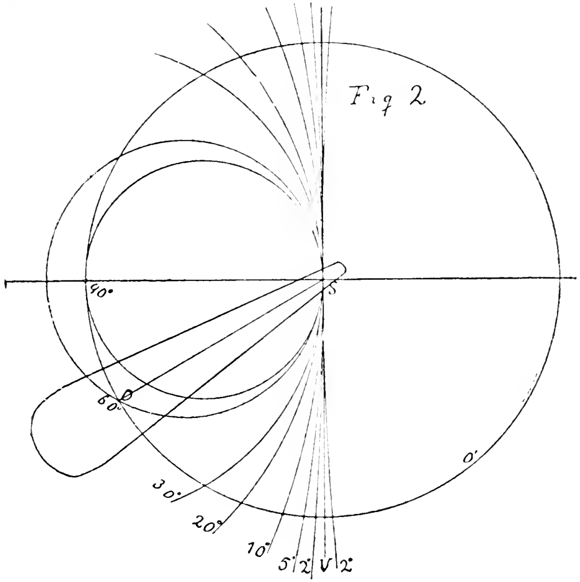
$$\mathrm{R}' = \sqrt{\frac{l}{\sin \theta} \left\{ \frac{l}{4 \sin \theta} - a \right\}} \tag{8}$$

If $a = 0$, we have the condition that the motion of a particle is unaffected by its connection with the system. The radius of this neutral circle is, therefore,

$$\mathrm{R}' = \tfrac{1}{2} \frac{l}{\sin \theta} \, . \tag{9}$$

Equation (7), then, becomes the equation of a circle containing the two points O and S, and tangent to VS at the point S.

When S O is horizontal R′ becomes $\frac{1}{2}l$, and when it is vertical $R' = \infty$. The position of the neutral circle, for various values of θ, is shown in Fig. 2. For a pendulum of 39 inches, vibrating 2 degs. on each side of the vertical, the radius of the neutral circle, or the distance of the common center, varies between $\pm$ 46 feet and $\pm\ \infty$.



Within the pendulum the circle never departs materially from the tangent SV, particles on the one side tending always to increase, while those on the other side tend to diminish the actual acceleration of the pendulum.

In (8) the condition $a = \frac{l}{4 \sin \theta}$, or $a = \frac{1}{2}R' = a'$, reduces the radius to zero. This gives the value of a at the center of the concentric circles. If the value of $\frac{l}{\sin\theta}$, as deduced from (9), be substituted in (8), it becomes

$$a = \tfrac{1}{2}R' - \frac{1}{2R'} R^2. \qquad (10)$$

This is the equation of a parabola the position of whose vertex is given by the conditions

$$y = 0,$$
$$x = R',$$
$$z = a' = \tfrac{1}{2}R',$$

the distance z being, of course, laid off at right angles to the plane of x, y. Revolving this parabola about its transverse axis, which is parallel to the axes O and S, the paraboloid of revolution obtained will represent the relation between a and R for every point in the field. The changes which this surface undergoes during an oscillation of the pendulum are very curious and interesting, but it is unnecessary to enlarge upon them here further than to remark that the focus of the paraboloid is always in the axis x, and its vertex is always in one of two right lines lying in a horizontal plane, and making an angle of 30 degs. with the axis x, and intersecting at S.

These considerations are wholly independent of the maximum amplitude of swing, and also of the geometry of the pendulum, excepting so far as it is involved in the distance l.

The concentric circles, which represent the isodynamic lines of the disc pendulum, are, of course, the right sections of coaxial cylinders, which represent the isodynamic surfaces of any compound pendulum.

When $\theta = 0$, these consecutive surfaces become a series of vertical and equidistant planes, as is shown by equation (6).

The Graphical Representation of the Relation between Valence and Atomic Weight.

By C. J. Reed.

PART I.

Valence as a Measure of Electro-Polarity.

The following discussion is an attempt to determine what relation, if any, exists between atomic weight and valence.

Whatever data could be obtained from reliable sources respecting atomic weights and valences was collected and tabulated for convenience. An interpretation of the data capable of a graphical representation was then sought. The interpretation finally adopted rests upon the following hypotheses :*

Hypoth. I.—*The valence of an atom is its capacity for electro-polarity.*

Hypoth. II.—*The polarity of an integrant molecule is always zero.*

Hypoth. III.—*Positive and negative changes of polarity are always contemporaneous and equal.*

Cor. I.—The sum of the positive polarities in any molecule is equal to the sum of the negative.

This follows directly from Hypoth. II.

All the atoms existing in a molecule are to be considered as polarized, one-half the atoms (measured in valence, not in numbers) positively, the other half negatively ; but an isolated atom, like a molecule, has no polarity toward any external atom or system. When an atom is in the "*nascent state*" it cannot be considered isolated.

An atom is *neutralized* when it is united with one or several atoms having the same degree of polarity, but of opposite sign. By neutralized we do not mean that the polarity is destroyed, but *opposed* by an equal and contrary polarity.

When a molecule is decomposed, the work done in separating

* These hypotheses were first announced in a different form by Mr. O. C. Johnson. See *Chem. News*, vol. 42, p. 51 ; also *Pharm. Record*, vol. 3, p. 394.

the ions is used in overcoming and virtually reducing to zero the polarities which held them together. This work is equivalent to the energy evolved when the ions reassume their polarities, i.e., when they reunite.

Two atoms united into a molecule may be compared to two permanent magnets united by their opposite poles and forming a molecule which would present no external polarity. If, now, these magnets be separated by removing one to an infinite distance, their polarities (toward each other, not their internal polarities) are reduced to zero; and the energy expended in removing the magnet reappears when they reassume their polarities, i.e., when they unite again.

The valence or capacity of an atom for electro-polarity may vary greatly, depending upon the intensity of the force tending to polarize it, that is, upon the valence of the ion with which it combines. The valence of many atoms, however, such as O, seems to be constant. The maximum and minimum valences of an atom represent the limits of its capacity for polarization, or its saturation points.

This conception may be more easily understood by reference to the illustration previously cited.

Let M and M′, Fig. 1, be two permanent magnets bent in the form of rings with their poles close together at NS and N′S′ respectively. Suppose the permanent magnetism is due not to any peculiar quality of the material, but to a perpetual electrical vortex-ring coinciding with the magnet.

Around each magnet is wound a coil of insulated wire, through which a current may be passed at will.

Suppose the poles of the magnet, M, are in actual contact. The magnet is then a closed ring and has no polarity. Suppose two such magnets are made to approach each other, and that this operation is equivalent to separating their poles. The two magnets now unite by their opposite poles as shown in Fig. 2, forming a molecule which is itself a closed magnetic ring having no external polarity. If the polarizing capacity (valence) of M is n times that of M′, it will require n of the latter to neutralize one of the former and produce a saturated molecule.

Suppose a current is passed through the coils so as to oppose the magnetism of the rings. If the magnetic field set up by the current equals that produced by the vortex-rings, the polarities become zero and the magnets fall apart. If the separation of the magnets breaks the circuit, the original magnetism due to the vorrex draws together the poles of each magnetic ring.

During the short interval between the separation of the ions and the closing of the magnetic ring the atom is in the "nascent state."

If the capacity of M, Fig. 2, is greater than that of M′, there will be a differential magnetic field between NS′ and SN′, which represents the tendency of the ions to either change capacity or take up additional atoms, either of which will reduce the polarity of the molecule to zero.

In all cases where O is evolved in the electrolytic cell, it appears at the positive pole. There is no impropriety, therefore, in assuming that *O is electro-negative to all other atoms.*

Certain general considerations, which are too well known to need repeating here, have led to the adoption of *sixteen* as the atomic weight and *two* as the valence of O. Hence, in this discussion the valence of O in all compounds is *minus two.*

When an alkali metal—N*a*, *K*, R*b*, or C*s*—is evolved in the electrolytic cell, it invariably appears at the negative pole and is therefore electro-positive. As C*s* is the most highly electro-positive of all known substances, it is safe to assume that this metal has a valence of *plus one* in all compounds. The valence of all other elements in any given compound can be determined by reference to O or its equivalent, and C*s* or some other alkaline metal.

As a rule all metals, including H, are + in binary compounds, while the non-metals are —. In ternary and more complex compounds both metals and non-metals are positive to oxygen. Those non-metals which exhibit both positive and negative valences possess, almost without exception, a well marked maximum and a well marked minimum which differ from each other by *eight units* of valence. This is shown in the following table:

Elem't.	Max.	Min.	Elem't.	Max.	Min.	Elem't.	Max.	Min.
H	+ 6 (?)	— 2	S*i*	+ 4	— 4	B*r*	+ 7	— 1
B	+ 3	....	P	+ 5	— 3	S*b*	+ 5	— 3
C	+ 4	— 4	S	+ 6	— 2	T*e*	+ 6	— 2
N	+ 5	— 3	C*l*	+ 7	— 1	I	+ 7	— 1
O	....	— 2	A*s*	+ 5	— 3	(H*g*	+ 6	— 2)?
F	....	— 1	S*e*	+ 6	— 2			

These values are not in all cases the most characteristic, though they are in many cases, as will be seen in Part II.

In compounds of two metals or two non-metals which cannot be electrolyzed it is difficult to determine which is + and which is −, though it is generally safe to say that the more basic element is + and the more acidic −. For example, it is probably safe to assume that in K_2H, Na_2H, CS_2, PCl_5 and PCl_3, K, *Na* C and P are + and H, S and *Cl* are −.

An isolated atom cannot be considered to have any valence; the polarity of such an atom is therefore zero. (Hypoth. II.)

If the foregoing hypotheses are true, the decomposition of a molecule must require an amount of energy proportional to the total change of valence produced, less the total energy evolved by the closing of atomic poles. In many cases the quantity of energy required to decompose a molecule is really negative. Nitro-glycerine is an example.

In all such cases the sum of the polarities of the individual atoms tending to close upon themselves or upon neighboring atoms is greater than the sum of the polarities tending to produce or hold together the molecule.

In Part II. are given the atomic weights and observed valences of the elements, and the principal compounds in which those valences occur. In compounds which cannot be electrolyzed the more basic elements are considered electro-positive, and the more acidic electro-negative. A summary is given in tabular form at the end, showing the maximum, minimum and *characteristic* valences. The characteristic valence is given only when it is different from the maximum and minimum.

PART II.

Valence and Atomic Weights of the Elements.

HYDROGEN.

Atomic weight 1.

H is — 2 in

K_2H, potassic hydride,
Na_2H, sodic "
*Cu*H, cupric "
PdH_2, palladic "

H is + 1 in

H*Cl* and all acids, as a basic radical,
H_3N and all ammonium compounds
H_3P and all phosphonium "
H_3As, hydric arsenide,
H_3Sb, " antimonide,
H_4C, " carbide and derivatives,
H_4Si, " silicide.

H is + 6 in

HP_2, hydric diphosphide.

LITHIUM.

Atomic weight 7.007 ± .007.

Li is + 1 in all compounds.

BERYLLIUM.

Atomic weight 9.085 ± .0055.

Be is + 2 in all compounds.

BORON.

Atomic weight 10.141 ± .023.

B is + 3 in all compounds.

CARBON.

Atomic weight 11.9736 ± .0028.

C is − 4 in

H_4C and may be −4 in some other hydro-carbons.

C is $-(2+{}^2/_n)$ in the series $H_{2n+2}C_n$, varying from − 4 to − 2 in

$H_4C, \quad -(2+\frac{2}{1}) = -4$
$H_6C_2, \quad -(2+\frac{2}{2}) = -3$
$H_8C_3, \quad -(2+\frac{2}{3}) = -2.67$
$H_{10}C_4, \quad -(2+\frac{2}{4}) = -2.5$
$H_{12}C_5, \quad -(2+\frac{2}{5}) = -2.4$

....

$\left(H_{2n+2}C_n, -(2+{}^2/_n)\right)_{n=\infty} = -2.$

C is − 2 in

$H_{2n}C_n$, the ethene series.

C is $-\left\{1+\frac{n-2}{n}\right\}$ in the series $H_{2n-2}C_n$, varying from −1 to −2 in

$H_2C_2, -\left\{1+\frac{2+2}{2}\right\} = -1$
$H_4C_3, -\left\{1+\frac{3-2}{3}\right\} = -1\frac{1}{3}$
$H_6C_5, -\left\{1+\frac{4-2}{4}\right\} = -1\frac{2}{4}$
$H_8C_5, -\left\{1+\frac{5-2}{5}\right\} = -1\frac{3}{5}.$

....

$(H_{2n-2}C_n), -(1+1) = -2.$

In all the series represented by the general expression $H_{2n\pm a}C_n$, we find for $n = \infty$, C is − 2. If we suppose n to vary between the limits + 1 and + ∞, a having any even integral value between + 2 and − 6 (its practical limits), the valence of C lies between 0 and −4.

If we next suppose *Cl* derivatives to be formed by substituting Cl^{-1} for H^{+1} in all these series, the valence of C then varies between 0 and −4.

C is + 2 in

+1+2−3
HCN and all cyanides,
CO, carbon monoxide.

C is + 3 in

+3−3
CN, cyanogen.

C is + 4 in

CO_2 and all carbonates,
CS_2 and all thio-carbonates,
$COCl_2$, carbonyl chloride,
$COBr_2$, " bromide(?),
$CSCl_2$, thio-carbonyl chloride,
H_4CN_2O, urea, and isomerides,
H_4CN_2S, sulpho-urea.

NITROGEN.

Atomic weight 14.021 ± .0035.

N is − 3 in

H_3N and all ammonic salts,
BN, boron nitride,
K_3N, potassic "
Cu_3N, cuprous "
CrN, chromic "
Zn_3N_2, zincic "
Hg_3N_2, mercuric "
VN, vanadium "
T_3N_4, titanic "
TaN, *tantalous* "
Ta_3N_5, *tantalic* "
HPN_2, phosphoric-hydric "
W_3N_2, tungstous "

N is + 1 in

N_2O, nitrous oxide,

KNO and all hyponitrites.

N is + 2 in

NO* and N_2O_2*, nitric oxide,

NS, nitrogen sulphide,

NS*e*, " selenide.

N is + 3 in

N_2O_3 and all nitrites,

NOC*l*, nitrosyl chloride,

NOB*r*, " bromide,

$NSClO_4$, nitro-sulphonic chloride,

$HNSO_5$, " acid,

$N_2S_2O_9$, " anhydride.

N is + 4 in

NO_2† and N_2O_4†, nitric peroxide.

N is + 5 in

N_2O_5 and all nitrates,

NO_2Cl, nitrosyl oxychloride.

OYGEN.

Atomic weight 15.9633 ± .0035.

O is — 2 in all compounds with other elements. See p. 664.

FLUORINE.

Atomic weight 18.984 ± .0065.

F is — 1 in all compounds.

SODIUM.

Atomic weight 22,998 ± .011.

N*a* is + 1 in

Na_2H, sodic hydride,

Na_2O and all sodic salts.

N*a* is + 2 in

Na_2O_2, sodic dioxide.

MAGNESIUM.

Atomic weight 23.959 ± .005.

M*g* is + 2 in all magnesic salts.

ALUMINIUM.

Atomic weight 27.009 ± .003.

A*l* is + 3 in all aluminic salts.

SILICON.

Atomic weight 28.195 ± .066.

S*i* is + 4 in

SiO_2 and all silicates,

SiF_4, silicic tetra-fluoride,

$SiCl_4$ " " chloride,

$SiBr_4$, " " bromide,

SiI_4, " " iodide.

S*i* is + 3 in

$SiCl_3$, silicic tri-chloride,

$SiBr_3$, " tri-bromide,

SiI_3, " tri-iodide,

$SiHO_2$, " hydric oxide.

S*i* is + 2 in

SiI_2, silicic di-iodide.

S*i* is — 4 in

H_4Si, hydric silicide.

PHOSPHORUS.

Atomic weight 30.958 ± .007.

P is — 3 in

H_3P and all phosphonium salts,

Cu_3P, cuprous phosphide,

Cu_3P_2, cupric "

Co_3P_2, cobaltous "

Fe_3P_2, ferrous "

Hg_3P_2, mercuric "

Zn_3P_2, zincic "

Ni_3P_2, nickelous "

Sn_3P_2, stannous "

W_3P_4, tungstous "

S_3P_4, sulphurous "

F*e*P, ferric "

M*o*P, molybdic "

P is — 2 in

H_2P, di-hydric phosphide,

Au_2P_3, di-auric "

S*n*P, stannous "

P is + 1 in

H_3PO_2 and all hypophosphites,

P_2S, phosphorus subsulphide.

P is + 2 in

PI_2, phosphorous di-iodide.

P is + 3 in

H_3PO_3 and all phosphites,

P_2S_3, phosphorus sulphide.

* These two bodies are both called nitric oxide.

† These bodies are both called nitric peroxide.

P is + 5 in
H_3PO_4 and all phosphates.

SULPHUR.

Atomic weight 31.984 ± .012.

S is — 2 in
H_2S and all sulphides,
HCyS and all thio-cyanates.

S may be — 1 in
H_2S_2, hydric disulphide.

S is + 1 in
S_2Cl_2, sulphur monochloride,
S_2Br_2, " monobromide,
S_2I_2, " moniodide.

S is + 2 in
SCl_2, sulphur dichloride,
$H_2S_2O_3$ and all thio-sulphates.

S is + 4 in
H_2SO_3 and all sulphites.

S is + 6 in
H_2SO_4 and all sulphates,
SI_6, sulphur-hexiodide.

CHLORINE.

Atomic weight 35.370 ± .014.

Cl is — 1 in
HCl and all chlorides.

Cl is + 1 in
HClO and all hypochlorites.

Cl is + 3 in
$HClO_2$ and all chlorites.

Cl is + 4 in
Cl_2O_4, chlorine peroxide.

Cl is + 5 in
$HClO_3$ and all chlorates.

Cl is + 7 in
$KClO_4$ and all perchlorates.

POTASSIUM.

Atomic weight 39.019 ± .012.

K is + 1 in
K_2H, potassic hydride,
K_2O and all potassic salts.

K is + 3 in
KI_3, potassic tri-iodide,
K_2S_3, " tri-sulphide.

K is + 4 in
KO_2, potassic dioxide,
KS_2, " disulphide.

K may be + 5 in
K_2S_5, potassic pentasulphide.

CALCIUM.

Atomic weight 39.99 ± .01.

Ca is + 2 in
CaO and all calcic salts.

Ca is + 4 in
CaC_2, calcic dioxide.

SCANDIUM.

Atomic weight 43.98 ± .015.

Sc is + 3 in
Sc_2O_3 and corresponding salts.

Note.—In order to conform to the law explained farther on, Sc ought to form a dioxide or some other quadrivalent compound. It ought really to form a series of salts corresponding to the ceric salts. It would then not only conform to the law, but fill a vacancy in the second series of "harmonics."

TITANIUM.

Atomic weight 48.001.

The recent experiments of Thorpe give the atomic weight of Ti 48.001. His results are the most concordant of any yet obtained, and are probably the most reliable.* They confirm the determination of Rose.

Ti is + 2 in
$TiCl_2$, titanium dichloride.

Ti is + 3 in
$TiO_{2/3}$, titanium sesquioxide,
$Ti_2(SO_4)_3$, " sesquisulphate,
Ti_2Cl_6, " sesquichloride,
$Ti_2O_2Cl_2$, " oxychloride.

* See *Chem. News*, vol. 48, p. 251, and vol. 51, p. 46.

Ti is + 4 in
TiO_2 and all titanic salts,
H_2TiF_6 and all titano-fluorides.

Note.—In order to conform to the law (see note on *Sc*) *Ti* should form either a tri-oxide, TiO_3, or a series of salts corresponding to the formula K_2TiO_4, which would bring it into closer relation to the S group.

VANADIUM.

Atomic weight 51.256.

V is + 1 in
V_2O, vanadium monoxide.

V is + 2 in
V_2O_2, vanadium dioxide,
V_2Cl_4, " dichloride.

V is + 3 in
V_2O_3, vanadium trioxide,
V_2Cl_6, " trichloride,
V_2Br_6 " tribromide,
$VOCl$, vandyl monochloride,
VN, vanadium nitride.

V is + 4 in
V_2O_4, vanadium tetroxide,
$V_2O_2(OH)_2$ and all hypovanadic salts,
$K_2V_4O_9$ and all hypovanadates,
VCl_4, vanadium tetrachloride,
$VOCl_2$, vandyl dichloride (hypovanadic chloride),
$VOBr_2$, vandyl dibromide (hypovanadic bromide),
V_2S_4, vanadium tetrasulphide.

V is + 5 in
V_2O_5 and all vanadates,
$VOCl_3$, vandyl trichloride and all true vandyl salts,
$K_3V_7O_{16}F_6$ and all fluo-oxyvanadates,
V_2S_5, vanadium pentasulphide.

V may be + 6 in
VN_2, vanadium dinitride.

Note.—With the atomic weigh given above, V, in order to conform to the law (see notes on *Sc* and *Ti*), ought to form a pervanadate, KVO_4. V would then be a connecting link between N and *Cl*.

CHROMIUM.

Atomic weight 52.129 ± .125.

Cr may be — 1 in
P*Cr*, phosphorous chromide.

Cr is + 2 in
$Cr(OH)_2$ and all chromous salts.

Cr is + 3 in
Cr_2O_3 and all chromic salts,
$ZnCr_2O_4$ and all chromites,
*Cr*N, chromic nitride(?),
Cr_2S_3, " sulphide.

Cr is + 6 in
CrO_3 and all chromates,
CrO_2Cl_2 and all chloro-chromates,
CrF_6, chromium hexfluoride.

Cr is + 7 in
Cr_2S_7, chromium heptasulphide,
$HCrO_4$, perchromic acid.

MANGANESE.

Atomic weight 54.95.*

Mn is + 2 in
*Mn*O and all manganous salts.

Mn is + $\frac{8}{3}$ in
Mn_3O_4, trimanganic tetroxide.

Mn is + 3 in
Mn_2O_3 and all manganic salts.

Mn is + 4 in
MnO_2, manganese dioxide,
MnS_2, " disulphide,
MnF_4, " tetrafluoride,
$MnCl_4$, " tetrachloride.
$K_2Mn_5O_{11}$ and all manganites.

Mn is + 6 in
$K_2Mn_2O_7$ and all manganates.

Mn is + 7 in
Mn_2O_7 and all permanganates,
MnO_3Cl, permanganic oxychloride.

* Dewar and Scott, *Chem. News*, vol. 47, p. 98. See also Marignac, *Arch des Sci. Phys. et Nat.* (3), 10, 21.

IRON.

Atomic weight $55.913 \pm .012$.

Fe is probably -2 in

H_2Fe, hydric ferride.

Fe is $+2$ in

FeO and all ferrous salts,

H_4FeCy_6 and all ferro-cyanides.

Fe is $+\frac{8}{3}$ in

Fe_3O_4, triferric tetroxide,

Fe_3Cl_8, ferroso-ferric chloride,

$Fe_3(SO_4)_4$, roemerite.

Fe is $+3$ in

Fe_2O_3 and all ferric salts,

H_3FeCy_6 and all ferri-cyanides,

$MgFe_2O_4$ and all ferrites,

$KFeS_2$ and all thio-ferrites,

FeP, ferric phosphide,

$FeAs$, " arsenide,

Fe_2S_3, " sulphide.

Fe is $+4$ in

FeS_2, iron disulphide,

Fe_3P_4, triferric tetraphosphide.

Fe is $+6$ in

K_2FeO_4 and all ferrates,

$FeAs_2$, lölingite.

NICKEL.

Atomic weight $57.928 \pm .022$.

Ni may be -1 in

$\overset{+5}{P}\overset{-1}{Ni_5}$, phosphorous pentanickelide.

Ni is $+2$ in

NiO and all nickel salts.

Ni_3P_2, nickelous phosphide.

Ni is $+3$ in

Ni_2O_3, nickelic oxide,

$Ni_2(OH)_6$, " hydrate,

$NiAs$ " arsenide (kupfernickel),

$NiSb$, nickel antimonide (breithauptite).

Ni is $+4$ in

NiS_2, nickel disulphide.

COBALT.

Atomic weight $58.887 \pm .008$.

Co is $+1$ in

Co_2S, cobalt subsulphide.

Co is $+2$ in

CoO and all cobaltous salts,

Co_3P_2, cobaltous phosphide.

Co is $+\frac{8}{3}$ in

Co_3O_4, tricobaltic tetroxide,

Co_3S_4, linnæite.

Co is $+3$ in

Co_2O_3 and all cobaltic and ammonio cobaltic salts,

K_3CoCy_6 and all cobalticyanides.

Co is $+4$ in

CoS_2, cobaltic disulphide,

$Co_2O_2(NO_3)_4(NH_3)_{10}$, ammonio-percobaltic nitrate.

COPPER.

Atomic weight 63.396.*

Cu may be $+\frac{1}{2}$ in

Cu_4O, copper suboxide,

Cu_6As, algodonite.

Cu is $+1$ in

Cu_2O and all cuprous salts,

Cu_3FeS_3, erubescite,

Cu_3As, domeykite

Cu_3N, cuprous nitride,

Cu_3P, " phosphide,

Cu is $+2$ in

CuO and all cupric salts,

$Cu\overset{-2}{H}$, cupric hydride,

Cu_3P_2, " phosphide,

Cu_3As_2, " arsenide.

Cu is $+4$ in

CuO_2, copper dioxide.

ZINC.

Atomic weight $64.90 \pm .019$.

Zn is $+2$ in

ZnO and all zincic salts,

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* M. H. Daubigny, *Chem. News*, Nov. 23, 1883. $SO_3 = 80$.

Zn_3N_2, zincic nitride,
Zn_3P_2, " phosphide,
ZnS, " sulphide.

GALLIUM.

Atomic weight 68.85.

Ga is + 3 in

Ga_2O_3 and corresponding salts.

ARSENIC.

Atomic weight 74.918 ± .016.

As is — 3 in

H_3As, hydric arsenide,
Cu_3As_2, cupric "
$FeAs$, ferric "
$NiAs$, nickelic "
(PAs, phosphorous arsenide)?

As is + 3 in

As_2O_3 and all arsenites,
As_2S_3 and all thio-arsenites,
AsF_3, arsenious fluoride,
$AsCl_3$, " chloride,
$AsBr_3$, " bromide,
AsI_3, " iodide.

As is + 5 in

As_2O_5 and all arsenates,
As_2S_5 and all thio-arsenates.

SELENIUM.

Atomic weight about 80.

The vapor-density of *Se*, taken at 1420°, is 80.5. This seems to indicate that the atomic weight, as determined by the best analyses, is too low. But the vapor-density cannot be relied upon, since at 142° *Se* may not be a perfect gas. The value, 80.5, is however nearer the one required by the law of Dulong and Petit. If we accept a compromise of these considerations, allowing analysis to weigh against specific heat and vapor-density, the approximate atomic weight of *Se* may be taken at about 80.

Another reason for accepting the high value is given on p. 672.

Se is — 2 in.

H_2Se and all selenides.

Se is + 1 in

Se_2Cl_2, selenium chloride,
Se_2Br_2, " bromide,
Se_2I_2, " iodide.

Se is + 2 in

$SeSO_3$, selenium sulphite.

Se is + 4 in

SeS_2, selenium disulphide,
SeO_2, and all selenites,
$SeCl_4$, selenium tetrachloride,
$SeBr_4$, " tetrabromide,
SeI_4, " tetraiodide,
$SeOCl_2$, selenyl chloride,
$SeOBr_2$, " bromide,
$SeOI_2$, " iodide.

Se is + 6 in

SeO_3 and all selenates.

BROMINE.

Atomic weight 79.768 ± 019.

Br is — 1 in

HBr and all bromides.

Br is + 1 in

$HBrO$ and all hypobromites.

Br is + 5 in

$HBrO_3$ and all bromates.

Br may be + 7 in

$HBrO_4$, hydric perbromate.

RUBIDIUM.

Atomic weight 85.251 ± .018.

Rb is + 1 in all compounds.

STRONTIUM.

Atomic weight 87.374 ± .032.

Sr is + 2 in

SrO and all strontic salts.

Sr is + 4 in

SrO_2, strontium dioxide.

YTTRIUM.

Atomic weight 89.816 ± .067.

Y is + 3 in

Y_2O_3 and all yttric salts.

ZIRCONIUM.

Atomic weight about 92.

Marignac's experiments, * the most reliable with which I am acquainted, give values for the atomic weight of *Zr* varying from less than 90 to more than 92. The higher value seems most likely to prove correct, though 90 is generally accepted.

Zr is + 4 in

ZrO_2 and all zirconium salts,
Na_2ZrO_3 and all zirconates,
K_2ZrF_6 and all zircono-fluorides.

COLUMBIUM.

Atomic weight 94(?).

Cb is + 5 in

Cb_2O_5, columbium pentoxide.

NIOBIUM.

Atomic weight 94.†

Nb is + 2 in

Nb_2O_2, niobium dioxide.

Nb is + 3 in

$NbCl_3$, niobium trichloride.

Nb is + 4 in

Nb_2O_4, niobium tetroxide.

Nb is + 5 in

Nb_2O_5 and all niobates,
$NbCl_5$, niobium pentachloride,
$NbBr_5$, " pentabromide.
NbF_5, " pentafluoride,
$NbOF_3$, niobyl fluoride,
$NbOCl_3$, " chloride,
$NbOBr_3$, " bromide.

MOLYBDENUM.

Atomic weight 96.009.‡

Mo is + 2 in

MoO, molybdenum monoxide,
$MoCl_2$, " dichloride,
$MoBr_2$, " dibromide,
$Mo_3Cl_4(OH)_2$, " chloro-hydrate
$Mo_3Cl_4Br_2$, molybdenum chloro-bromide.
$Mo_3Br_4(OH)_2$, " bromo-hydrate,
$Mo_3Br_4Cl_2$, " bromo-chloride,
$Mo_3Br_4F_2$, " bromo-fluoride,
$Mo_3Br_4SO_4$, " bromo-sulphate.

Mo is + 3 in

Mo_2O_3, molybdenum sesquioxide,
Mo_2Cl_6, " sesquichloride,
Mo_2Br_6, " sesquibromide,
MoP, " phosphide.

Mo is + 4 in

MoO_2, molybdenum peroxide,
$Mo(OH)_4$, " hydrate,
MoS_2, " disulphide,
$MoCl_4$, " tetrachloride,
$MoBr_4$, " tetrabromide,
MoI_4, " tetra-iodide.

Mo is + 5 in

$MoCl_5$, molybdenum pentachloride
Mo_2O_5, " pentoxide.

Mo is + 6 in

MoO_3 and all molybdates,
MoS_3 and all thio-molybdates,
Mo_2OCl_4, molybdyl tetrachloride,
MoO_2Cl_2, " oxychloride,
MoO_2Br_2, " oxybromide,
MoO_2F_2, " oxyfluoride.

RHODIUM.

Atomic weight about 104.

Rh is + 2 in

RhO, rhodium monoxide,
RhS, " monosulphide.

Rh is + 3 in

Rh_2O_3 and all rhodic salts.

Rh is + 4 in

RhO_2, rhodium dioxide,
$Rh(OH)_4$, " tetrahydrate.

RUTHENIUM.

Atomic weight about 104.

Ru is + 2 in

RuO, ruthenium monoxide,

* *Ann. Chem. Phys.* (3), 60, 270, 1860. † *Ann. Chem. Phys.* (4), viii., 16.

‡ O = 16, Rammelsberg, *Berlin Monatsbericht*, 1877, 574. Dumas, *Ann. Chem. Pharm.* 105, 84 and 113, 23. *Mo* = 95, 92.

$RuCl_2(NH_3)_4$ and all ruthenio-di-ammonium salts,
H_4RuCy_6 and all ruthenio-cyanides

Ru is +3 in

Ru_2O_3 and all ruthenious salts,
Ru_2S_3, laurite.

Ru is +4 in

RuO_2 and all ruthenic salts.

Ru is +6 in

K_2RuO_4, potassic ruthenate.

Ru is +7 in

$KRuO_4$, potassic per-ruthenate.

Ru is +8 in

RuO_4, ruthenium tetroxide.

PALLADIUM.

Atomic weight about 108.*

Pd is +1 in

Pd_2O, palladium suboxide,
Pd_2S, " subsulphide.

Pd is +2 in

PdO and all palladious salts,
$PdCl_2(NH_3)_2$ and all ammonio-palladium salts.

Pd is +4 in

PdO_2 and all palladic salts,
PdS_2, palladium disulphide,
Na_2PdS_3, sodic thio-palladate,
PdH_4, palladic hydride.

SILVER.

Atomic weight 107.675 ± .0096.

Ag is +½ in

Ag_4O, silver suboxide,
Ag_2Cl, " subchloride.

Ag is +1 in

Ag_2O and all argentic salts.

Ag is +2 in

Ag_2O_2, silver dioxide.

Ag is +3 in

$(AgAu)_2Te_3$, sylvanite.

CADMIUM.

Atomic weight 111.835 ± .024.

Cd is +2 in

CdO and all cadmic salts.

INDIUM.

Atomic weight 113.398 ± .047.

In is +3 in

In_2O_3 and all indic salts.

TIN.

Atomic weight 117,698 ± .040.

Sn is +2 in

SnO and all stannous salts,
Sn_3P_2, stannous phosphide.
K_2SnO_2 and all stannites.

Sn is +4 in

SnO_2 and all stannic salts,
K_2SnO_3 and all stannates.

ANTIMONY.

Atomic weight 122.46.

The investigations of Dexter, Dumas and Kessler all point to a high value for the atomic weight of Sb, while those of Cooke point to a value not above 120. The number obtained by Dexter,† 122.46, gives the atomic heat 6.22.

Sb is −3 in

H_3Sb, hydric antimonide,
Ag_3Sb, argentic "
NiSb, nickelic "

Sb is +3 in

Sb_2O_6 and all antimonites,
Sb_2S_3 and all thio-antimonites,
Sb_2Se_3, antimonious selenide,
SbF_3, " fluoride,
$SbCl_3$, " chloride,
$SbBr_3$, " bromide,
SbI_3, " iodide,

* Berzelius (*Pogg. Ann.* 8, 177, 1826) analyzed K_2PdCl_4 and obtained values varying from 104.7 to 110.8, the mean of which was (O = 16) 107.6. These figures are evidently of little value, yet they are sufficient to justify using the round number, 108, until a more accurate determination is made.

† O = 16, *Pogg. Ann.* 100, 563.

$Sb_2(SO_4)_3$, antimonious sulphate,
$SbOCl$, antimonyl monochloride.

Note.—Most thio-antimonites are found native, such as

$FeSb_2S_4$, berthierite,
$Cu_2Sb_2S_4$, wolfsbergite,
$PbSb_2S_4$, boulangerite,
$Pb_2Sb_2S_5$, bleinierite,
$(Cu_2Pb)_3Sb_2S_6$, bournanite,
$Ag_{10}Sb_2S_8$, freislebenite,
$Ag_6Sb_2S_6$, pyrargyrite,
&c., &c.

Sb is + 4 in
Sb_2O_4 and all hypo-antimonates.

Sb is + 5 in
Sb_2O_5 and all antimonates,
Sb_2S_5 and all thio-antimonates,
Sb_2Se_5 and all seleno-antimonates,
SbF_5, antimonic fluoride,
$SbCl_5$, " chloride,
$SbOCl_3$, antimonyl trichloride.

IODINE.

Atomic weight 126.557 ± 0.22.

I is — 1 in
HI and all iodides.

I is + 1 in
ICl, iodine monochloride.

I is + 3 in
ICl_3, iodine trichloride.

I is + 5 in
HIO_3 and all iodalts.

I is + 7 in
H_5IO_6 and all periodates.

TELLURIUM.

Atomic weight 127.96 ± .034.

Te is — 2 in
H_2Te and all tellurides.

Te is + 2 in
$TeCl_2$, tellurium dichloride,
$TeBr_2$, " dibromide,
TeI_2, " di-iodide

Te is + 4 in
TeO_2 and all tellurites,
TeS_2 and all thio-tellurites,
TeF_4, tellurium tetrafluoride,
$TeCl_4$, " tetrachloride,
$TeBr_4$, " tetrabromide,
TeI_4, " tetraiodide.

Te is + 6 in
TeO_3 and all tellurates.
TeS_3, and all thio-tellurates.

CÆSIUM.

Atomic weight 132.583 ± .024.

Cs is + 1 in
$CsOH$ and all cæsic salts.

BARIUM.

Atomic weight 136.763 ± .031.

Ba is + 2 in
BaO and all baric salts.

Ba is + 4 in
BaO_2, barium dioxide.

LANTHANUM.

Atomic weight 139.0.*

La is + 3 in
La_2O_3 and all lanthanic salts.

CERIUM.

Atomic weight 140.†

Ce is + 3 in
Ce_2O_3 and all cerous salts,
Ce_2S_3, cerous sulphide.

Ce is + 4 in
CeO_2 and all ceric salts.

DIDYMIUM.

Atomic weight about 140.

This metal has recently been separated by Welsbach into *neodym* and *praseodym*. See *Chem. News*, vol. 52, p. 49.

SAMARIUM.

Atomic weight about 150.

* Cleve, *K. Svenska. Vet. Akad. Handlingar*, Bd. 2, no. 7, 1874.
† Robinson, *Chem. News*, vol. 50, p. 251.

Sm is $+3$ in

Sm_2O_3, samarium oxide,

$Sm_2(SO_4)_3$, " sulphate.

ERBIUM.

Atomic weight 171.*

Er is $+3$ in

Er_2O_3 and all erbic salts.

YTTERBIUM.

Atomic weight about 173.†

Yb is $+3$ in

Yb_2O_3 and all ytterbic salts.

TANTALUM.

Atomic weight 182(?).

Ta is $+3$ in

TaN, tantalous nitride.

Ta is $+4$ in

TaO_2, tantalum di-oxide,

TaS_2 " disulphide.

Ta is $+5$ in

Ta_2O_5 and all tantalates,

TaF_5 and all tantalo-fluorides,

$TaCl_5$, tantalic chloride,

Ta_3N_5, " nitride.

TUNGSTEN.

Atomic weight about 184.‡

W is + is 2 in

WCl_2, tungsten dichloride,

WBr_2, " dibromide,

WI_2, " di-iodide,

W_3N_2, " nitride.

W is $+4$ in

WO_2, tungsten dioxide,

WS_2, " disulphide,

WCl_4, " tetrachloride,

W_3P_4, " tetraphosphide.

W is $+5$ in

WCl_5, tungsten pentachloride,

WBr_5, " pentabromide.

W is $+6$ in

WO_3 and all tungstates,

WS_3 and all thio-tungstates, [states

$H_8PtW_{10}O_{36}$ and all platino-tung-

$H_8SiW_{10}O_{36}$ and all silico-tungstates,

$H_{11}PW_{10}O_{38}$ and all phospho-decatungstates,

$K_2WO_2F_4$, potass. tungsto-fluoride

WCl_6, tungsten hexchloride,

$WOCl_4$, tungstyl tetrachloride,

WO_2Cl_2 " oxychloride,

WO_2Br_2, " oxybromide.

IRIDIUM.

Atomic weight 193 0.‡

Ir is $+2$ in

$IrSO_3$ and other iridium subsalts,

IrS, iridium monosulphide.

Ir is $+3$ in

Ir_2O_3 and all iridious salts,

Ir_2S_3, iridious sulphide,

H_3IrCy_6 and all iridicyanides.

Ir is $+4$ in

IrO_2 and all iridic salts,

IrS_2, iridic sulphide.

PLATINUM.

Atomic weight about 195.‡

Pt is $+1$ in

$Pt_2(OH)_2(NH_3)_4$ and all diplato-diammonium salts.

Pt is $+2$ in

PtO and all platinous and ammonio-platinous salts,

K_2PtCl_4 and all chloro-platinites,

$K_2Pt(NO_2)_4$ and all platino-nitrites

H_2PtCy_4 and all platino-cyanides,

$H_2Pt(CyS)_4$ and all platino-thiocyanates,

PtS, platinous sulphide.

Pt is $+3$ in

$Pt_2I_6(NH_3)_3$, diplatinammonium iodide,

$Pt_2I_6(NH_3)_8$ and all diplatin-tetrammonium salts,

Pt_2S_3, platinum sesquisulphide.

Pt is $+4$ in

PtO_2 and all platinic and ammonio-platinic salts,

PtS_2, platinic sulphide,

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* Hoeglund. *K. Svenska. Vet. Akad. Handlingar*, Bd. 1, no. 6; also Humpidge and Burney, *Jour. Chem. Soc.*, Feb., 1879, p. 116.

† Nilson, *Compt. Rend.*, 91, 56, 1880.

‡ O = 16.

$H_8PtW_{10}O_{36}$ and all platino-tungstates.

$H_8PtMo_{10}O_{36}$ and all platino-molybdates,

K_2PtCl_6 and all chloro-platinates,

$H_2Pt(CyS)_6$ and all platinothio-cyanates.

Pt may be + 6 in

PtP_2, platinum diphosphide,

$PtAs_2$ " di-arsenide.

GOLD.

Atomic weight 196.6.*

Au is + 1 in

Au_2O and all aurous salts,

$NaAuS$, sodic aurous sulphide.

Au is + 2 in

AuO, gold monoxide,

AuS, " monosulphide,

$AuCl_2$ " dichloride.

Au is + 3 in

Au_2O_3 and all auric salts and aurates,

Au_2Te_3, sylvanite.

Au is + 4 in

AuO_2, gold dioxide,

$AuTe_2$, calaverite.

OSMIUM.

Atomic weight about 199.

Os is + 2 in

OsO, osmium monoxide,

$OsSO_3$, " sulphite,

$K_6H_2Os(SO_3)_5$, osmium potassic sulphite,

H_4OsCy_6 and all osmio-cyanides.

Os is + 3 in

Os_2O_3, osmium sesquioxide,

$K_6Os_2Cl_{12}$, potassic osmichloride,

$(NH_4)_6Os_2Cl_{12}$, ammonic "

Os is + 4 in

OsO_2, osmium dioxide,

$OsCl_4$. " tetrachloride,

K_2OsCl_6, di-potassic osmichloride,

Na_2OsCl_6, di-sodic osmichloride,

$(NH_4)_2OsCl_6$, diammonic "

Os is + 6 in

K_2OsO_4 and all osmates,

$OsO_2Cl_2(NH_3)_4$, ammonio-osmyl-oxydichloride.

Os is + 7 in

$H_2Os_2\overset{-3}{N_2}O_5$ and all osmiamates.

Note.—In this compound N is in the same condition as in H_3N, and not as in N_2O_5. This is shown by the following equation:

$$2\overset{+8\,-2}{OsO_4} + 2\overset{+1\,-3}{H_3N} + 2\overset{+1\,-2\,+1}{KOH} = \overset{+1\,+7\,-3\,-2}{K_2Os_2N_2O_5} + \overset{\pm 0}{O} + 4\overset{+1\,-2}{H_2O}.$$

Os is + 8 in

OsO_4, osmium tetroxide,

OsS_4, " tetrasulphide.

MERCURY.

Atomic weight 199.712 ± .042.

Hg is + 1 in

Hg_2O and all mercurous and ammonio-mercurous salts.

Hg is + 2 in

HgO and all mercuric and ammonio-mercuric salts

HgS, mercuric sulphide,

Hg_3P_2, " phosphide,

Hg_3N_2, " nitride.

Hg is + 6 in

HgI_6, mercuric hexiodide.

Hg is — 2 in

K_2Hg, potassic hydrargyride.

THALLIUM.

Atomic weight 204.

Tl is + 1 in

Tl_2O and all thallious salts,

Tl_2S, thallious sulphide.

Tl is + 2 in

$TlCl_2$, thallium dichloride.

Tl is + 3 in

Tl_2O_3 and all thallic salts,

* O = 16.

Tl_2S_3, thallic sulphide,
$KTlS_2$, potassic thallic sulphide.

LEAD.

Atomic weight 200.47 ± .02.

Pb is + 1 in

Pb_2O, plumbous oxide,
Pb_2S, " sulphide.

Pb is + 2 in

PbO and all plumbic salts,
PbS, plumbic sulphide,
K_2PbO_2 and all plumbites.

Pb is + 3 in

Pb_2O_3, lead sesquioxide.

Pb is + 4 in

PbO_2 and all plumbates,
$PbCl_4$, lead tetrachloride.

BISMUTH.

Atomic weight 207,523.*

Bi is + 2 in

Bi_2O_2, bismuth monoxide,
Bi_2S_2, " monosulphide,
$BiCl_2$, " dichloride,
$Bi_4O_3Cl_2$, " trioxydichloride,
Bi_4O_3S, karelinite.

Bi is + 3 in

Bi_2O_3 and all bismuthic salts,
Bi_2S_3, bismuthic sulphide,
Bi_2Se_3, " selenide,
Bi_2Te_3, bismuthic telluride,
$BiSCl$, " thio-chloride,

Bi is + 4 in

Bi_2O_4, bismuth tetroxide.

Bi is + 5 in

Bi_2O_5 and all bismuthates.

THORIUM.

Atomic weight 232.0.†

Th is + 4 in

ThO_2 and all thorium compounds.

URANIUM.

Atomic weight 239.

U is + 3 in

U_2Cl_6, uranium sesquichloride.

U is + 4 in

UO_2 and all uranous salts.

U is + 5 in

U_2O_5, uranium pentoxide,
UCl_5, uranium pentachloride.

U is + 6 in

UO_3 and all uranates and uranyl salts.
UO_2S, uranyl sulphide.

U is + 8 in

UO_4, uranium tetroxide.

U is + 12 in

K_4UO_8, potassic peruranate,
Na_4UO_8, sodic "

In the following list of compounds the valence cannot be stated with any certainty:

SnP	CdS_5	U_3O_8	$K_2W_5O_{12}$
HO	ZnS_5	W_3O_8	$Pt_2I_5(NH_3)_4$
HAs	BaS_4	Mo_3O_8	$Mo_2Cl_5O_3$
Fe_2N	BaS_3	Cr_4O_5	$K_2W_3O_9$
Fe_2P	$CoAs_3$	Fe_5N_2	$Na_2W_3O_9$
Ni_2P	NaS_2	Cu_5As_2	$H_2Pt_4S_6$
W_2P	AsS_2	Na_2S_5	Fe_2S_2As
Ag_2Sb	$FeAs_2$	Mg_5Si_3	Se_2SAs
Au_2Bi	$CoAs_2$	Cr_5O_6	S_2SeAs
O_2O (ozone)	AlB_2	Cr_5O_9	$Cr_3Cl_2O_6$
Ag_4Sb	Na_2S_3	Mo_5O_{11}	$Pt_4I_9(NH_3)_8$
Pb_4S	Pb_3O_4	Cu_9As	$Bi_6S_4O_3$
Cu_4As	P_3Fe_4	Sn_9P	$NbOS_3$
BaS_5	U_3Cl_8	K_2FeCy_5NO	

* Schneider, *Pogg. Ann.* 82. 303, 1859.

† Nilson, *Berichte*, 15, 2527, 1882.

TABLE OF ATOMIC WEIGHTS AND VALENCES.

Element.	Atomic Weight.	Maximum.	Minimum.	Char'teristic.
H	1.	+ 6	— 2	+ 1
Li	7.007	+ 1		
Be	9.085	+ 2		
B†	10.941	+ 3		
C	11.9736	+ 4	— 4	
N	14.021	+ 5	— 3	
O	15.9633		— 2	
F†	18.984		— 1	
Na	22.998	+ 1		
Mg	23.959	+ 2		
Al	27.009	+ 3		
Si	28.195	+ 4	— 4	
P	30.958	+ 5	— 3	
S	31.984	+ 6	— 2	
Cl	35.370	+ 7	— 1	
K	39.019	+ 1		
Ca	39.99	+ 2		
Sc†	43.98	+ 3		
Ti†	48.001	+ 4		
V†	51.256	+ 6		+ 5
Cr	52.009	+ 7	— 1	+ 6
Mn	54.95	+ 7		
Fe	55.913	+ 6	— 2	+ 3
Ni	57.928	+ 4	— 1	+ 2
Co	58.887	+ 4		+ 2
Cu	63.396	+ 4		+ 2
Zn	64.90	+ 2		
Ga	68.85	+ 3		
As	74.918	+ 5	— 3	+ 3
Se	80.	+ 6	— 2	
Br	79.768	+ 7	— 1	
Rb	85.251	+ 1		
Sr	87.374	+ 4		+ 2
Y†	89.8	+ 3		
Zr	92.	+ 4		
Cb†	94.?	+ 5		
Nb†	94	+ 5		
Mo	96.009	+ 6		
Rh	104.	+ 4		+ 3
Ru	104	+ 8		+ 3 + 4
Ag	107.675	+ 2		+ 1
Pd	108.	+ 4		
Cd	111.835	+ 2		
In	113.398	+ 3		
Sn	117.698	+ 4		
Sb	122.46	+ 5	— 3	
I	126.557	+ 7	— 1	
Te	127.96	+ 6	— 2	
Cs	132.58	+ 1		
Ba	136.76	+ 4		+ 2
La	139.0	+ 3		
Ce	140	+ 4		
Di	142.*			
Sm†	150.	+ 3		
Er†	171.	+ 3		
Yb†	173	+ 3		
Ta†	182.?	+ 5		
W	184.	+ 6		
Ir	193.	+ 4		
Pt	195.	+ 6		+ 4
Au	196.6	+ 4		+ 3
Os	199.	+ 8		+ 6
Hg	199.712	+ 6	— 2	+ 2
Tl	204.	+ 3		
Pb	206.47	+ 4		+ 2
Bi	207.5	+ 5		+ 3
Th	232.0	+ 4		
U	239.	+12		+ 6

† Neither vapor-density nor specific heat have been determined.

* See p. 661.

PART III.

The Graphical Representation of the Relation between Atomic Weight and Valence.

Let $Z Z'$ and $Y Y'$, Plate I., be any two rectangular axes with the origin at O. Let z represent the atomic weight and y the valence $\times 10$ of any element. Locate a point in the plane for the maximum, minimum, and characteristic valence of each element.

Nearly all of these points are found to lie on a double series of parallel lines, the successive pairs of which are separated by equal distances; and the general equation for any of the lines is

$$y = 5z + b, \quad - \quad - \quad - \quad - \quad - \quad (1).$$

The values of b for the successive lines are almost exactly as follows:

			Diff.
First line	b,	$= + 55$	
Second "		$= - 20$	75
Third "		$= - 25$	5
Fourth "		$= - 100$	75
Fifth "		$= - 105$	5
Sixth "		$= - 180$	75
Seventh "		$= - 185$	5

If we accept Prout's hypothesis, these values are *exact;* and the actual deviation does not exceed, in the mean, .035 of the unit in the first seventeen elements, if we exclude *Cl*, whose deviation will be accounted for later. If we include *Cl*, the mean deviation is .056. The algebraic sum of the deviations of these elements divided by the number of elements (17) is, including *Cl*, .021; excluding *Cl*, .0051.

These deviations are so small that they cannot, except in *Cl* and *Si*, be represented graphically without using a much larger scale.

At *Sc*, however, we find an abrupt termination of what appears to be a rigid law for the first seventeen elements.

If we construct a complete series of lines according to the law indicated on the diagram by assigning to b in equation (1) successively, values which diminish by 75 and 5 alternately, we shall find that most of the elements fall on or very near one of these lines.

What is the meaning of these singular coincidences, and particularly the regular *oscillation* from one line to the opposite as we pass from O to *Cl*? This oscillation is shown in Fig. 3.

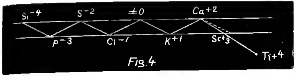


Fig. 4.

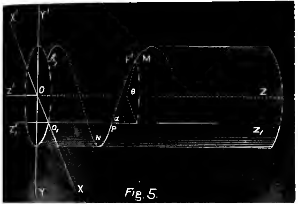


Fig. 5.

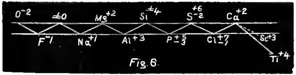


Fig. 6.

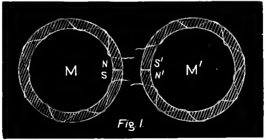


Fig. 1.

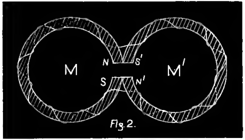


Fig. 2.

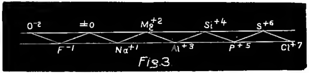


Fig. 3.

PLATE I. Showing the Relation between Valence and Atomic Weight.

On the next pair of lines we find again the same vibratory movement. See Fig. 4.

The peculiar position occupied by Si, P, S, and Cl, at the posititive end of the first pair of lines and the negative end of the second, shows that *the second pair is only a continuation of the first through a vertical displacement of eight units of valence, corresponding to an increase of sixteen units of atomic weight.*

This points to the conclusion that *saturation-valence is an equicrescent rotary function of atomic weight.*

To represent this idea graphically we must locate the points on the surface of a cylinder instead of a plane.

Let Q Q′, Fig. 5, be any cylinder referred to the rectangular axes, X X′, Y Y′, and Z Z′ (its own axis), and having the origin at O.

Let R be the radius of the cylinder, and MN any line drawn around the cylinder so that the angle $MPz_1 = a$, a constant; $z_1 z'_1$ being the element of the cylinder which passes through any point, P, of the line MN. Then will the line MN be a helix, and

$$z \tan a = R(\theta + b) \quad - \quad - \quad - \quad . \qquad (2).$$

its general equation when referred to any element, $z_1 z'_1$, of the cylinder and the circumference ($R = \sqrt{x^2 + y^2}$, $z = o$) of the cylinder lying in the plane, X X′, Y Y′; the intersection, o_1, being the origin; θ the angular departure of any point, P′, of the line MN measured upward from the element, $z_1 z_1'$, as origin of the arc; and b, the angular departure of the point of intersection, b_1, of the line MN with the plane X X′, Y Y′.

Let z be the atomic weight of any chemical element; $R\theta$ its saturation-valence $\times$ 10. Assume $R = \frac{40}{\pi}$ and $\tan a = 5$. Then if $b = b_1 = -\frac{\pi}{2}$, we have from (2)

$$z \tan a = R\theta - \frac{\pi R}{2} \quad - \quad - \quad - \qquad (A).$$

This is the equation of the artiads.

If $b = b_1 = -\frac{5\pi}{8}$, we have

$$z \tan a = R\theta - \tan^2 a \quad - \quad - \quad - \qquad (B).$$

This is the equation of the perissads. See Pl. II.

CONCLUSION.

Whether the conclusion, stated on p. 667, that saturation-valence is an equicrescent rotary function of atomic weight, is the expression of a natural law, or of a mere coincidence, I leave for others to decide.

If it is only a chance coincidence, we must acknowledge it to be a remarkable one. A coincidence which unites *not less than fifty chemical elements* by so simple a relation between valence and atomic weight as $y = ax + b$, must be entitled to some consideration.

Mendelejeff has shown that "*the chemical properties of the elements are a periodic function of their atomic weights.*"

This statement, while it is true enough, is too indefinite to be called the statement of a *law*, since a law must be capable of some quantitative mathematical expression.

Mendelejeff's statement is so ingeniously framed as to link together in a *qualitative* expression all or nearly all chemical facts, without alluding to any one of the individual laws embraced in his generalization. The manner in which he predicted the discovery of gallium and scandium, by the periodic recurrence of certain chemical and physical properties corresponding to periodic numerical relations between the atomic weights of known elements, shows conclusively that many of these unknown laws have the common factor, *atomic weight.*

There is room for as many of these laws as there are different properties recognizable in matter.

In the graphical representation, explained above, for the law of valence we find a remarkable expression of the "periodic function."

Prout's hypothesis is merely the expression of a single fact embraced in the law.

The changes in the atomic weights required by this law are such as would generally favor the law of Avogadro and that of Dulong and Petit, and would make the atomic volume curves of Meyer more regular.

These changes would affect few, if any, of those elements whose atomic weights have been established with tolerable certainty.

The full expression of the law would require the existence of 105 elements whose atomic weights lie between 1 and 240.

These elements would be arranged in seven groups of fifteen each. The number of elements required for each whorl of the helix is seven, each representing a distinct group.

The successive elements in any single whorl form a series, and may be conceived to represent successively increasing velocities of rotation of a primordial atom or particle of ether—possibly the vortex-ring of Sir W. Thompson. Each successive whorl would represent an *octave*, and the successive elements in any one group represent *harmonics* of the first or lowest in that group.

According to this conception N*a*, K, R*b*, and C*s*, are respectively the first, second, fifth and eighth harmonics of L*i*; F, C*l*, B*r*, and I, the first, second, fifth and eighth harmonics of some unknown element marked γ_1, whose atomic weight is 3.

P, V (?), A*s*, N*b*, S*b*, Bi, and U (?), are harmonics of N; and so with the remaining groups, the fundamentals being H, γ_1 (unknown), L*i*, B*e*, B, C, and N.

The complete expression of the law would require each element to be represented by two well marked and characteristic valences, one electro-positive and the other electro-negative, whose difference is eight units. This we find to be true of a considerable number of elements, those enumerated on page 651. But, as would naturally be expected, we have not yet observed the electro-negative or minimum valence in the highly electro-positive elements.

The question now arises, why are not all the elements arranged on a single line, instead of the *artiads* on one and the *perissads* on another?

Let us confine our attention to that part of the curve between O and C*a*, as it seems to represent the law most perfectly. It is shown in Fig. 6.

If we increase the valence of the perissads in this part of the curve by a half unit, they fall with the artiads on the curve, $z \tan \alpha = R\theta - \frac{\pi R}{2}$. This may mean that the valence of the perissads is half a unit less than that required by their atomic weights.

If polarity is due to rotation of any kind, we may say a perissad is half a revolution behind the opposite artiad.

The curve $R\theta = \frac{1}{2} z \tan \alpha$ is also worthy of mention. The elements S*c*, T*i*, and $\overset{+6}{\underset{-2}{\mathit{Fe}}}$, fall on this curve, which may be the expression of some constant error or undetermined relation.

The elements which conform as nearly as could be reasonably expected are H, L*i*, B*e*, B, C, N, O, F, N*a*, M*g*, A*l*, S*i*. P, S, C*l*. K, C*a*, R*b*, S*r*, Y, Z*r*, N*b*, C*b*, M*o*, *Pd*, T*e*, B*a*, L*a*, C*e*, E*r*, H*g*, T*l*. P*b*, B*i*, I, A*s*, S*b*, B*r*, and S*e*, thirty-nine in all.

The curves pass through maximum and minimum "characteristics" of C, N, S*i*, P, S, S*e*, C*l*, and T*e*; through maximum characteristics of L*i*, B*e*, B, N*a*, M*g*, A*l*, K, C*a*, R*b*, Y, Z*r*, N*b*, C*b*, M*o*, P*d*, L*a*, C*e*, E*r*, and T*l*, in which negative valence has not been observed; through minimum characteristics of O and F, in which positive valence has not been observed; through characteristics not maxima or minima of S*r*, B*a*, H*g*, I, A*s*, S*b*, B*r*; through maxima or minima not characteristics of H, P*b*, and B*i*.

A few other elements have known, though not maximum, minimum or characteristic valences lying on the curves. Among them are $\overset{+3}{\mathit{Co}}$, $\overset{+3}{\mathit{Ni}}$, $\overset{+2}{\mathit{Ru}}$, $\overset{+2}{\mathit{Rh}}$, $\overset{+2}{\mathit{Fe}}$, $\overset{+5}{\mathrm{U}}$, $\overset{+2}{\mathrm{W}}$, and $\overset{+1}{\mathit{Au}}$. No importance, however, can be attached to this fact.

The first prominent exceptions we find to the law are the elements immediately following C*a*. These are S*c*, T*i*, V, C*r*, and F*e*. The deviation of S*c*, T*i*, and F*e*, may be accounted for in the manner suggested on p. 669.

The atomic weight of C*r* should be 51 instead of 52, in order to bring its maximum-minimum point on the curve. This confirms the results of Siewert's* determinations. The deviation of C*r* is not at all surprising, when we remember that improved methods of determining the atomic weight of C*r* have steadily reduced it from 56 to 52.009.

Vanadium also may be considered as a candidate for the position of γ_2, Pl. II. Its atomic weight and many of its properties favor this view; and it lacks only the power of forming a *pervanadate*, KVO_4; or a *hydrovanadic acid*, HV, or some corresponding salt.

The fact that certain perissads, viz., R*b*, C*b*, N*b*, and Y, whose atomic weights are still uncertain, fall on the curve of artiads, may be regarded as evidence that their position is entirely acci-

* *Zeitschrift Gesammt. Wissenschaften*, 17, 530, 1861.

dental, and that their atomic weights are affected by a negative error of about one unit. We shall class these elements, therefore, along with *Sn* and *Cs* as exceptions whose atomic weights are too low. The correctious required are

Atomic Weight.		Corrections.
R*b*	85.251	+ 1.749
Y	89.8	+ 1.2
C*b*	94.	+ 1.
N*b*	94.	+ 1.
S*n*	117.698	+ 2.302
C*s*	132.58	+ 2.42

The deviations of some of these might reasonably be attributed to experimental errors. But I prefer to consider them all exceptions, and would even add A*s*, B*r*, I and S*b* to the list, though they appear to conform regularly to the law. It will be remembered that the curves pass through the characteristics of A*s*, B*r*, I and S*b*, instead of their well marked maxima and minima, as we should naturally expect. To bring the maxima and minima of these elements on the curves in their regular places would require the following corrections:

Atomic Weight.		Corrections.
A*s*	74.918	+ 4.082
B*r*	79.768	+ 3.232
I	126.557	+ 4.443
S*b*	122.46	+ 4.54

Such large deviations cannot in these elements be attributed to ordinary experimental errors. They may, however, all be referred to a common cause, viz., *the presence of unknown elements which tend to reduce the apparent atomic weights of those elements with which they are associated and with which they have been hitherto confounded.**

The unknown elements to which I refer are such as would fill the vacant "harmonics" in the seven groups.

In the C*l* group, for instance, we find two vacancies between C*l* and B*r*, two between B*r* and I, and one below F, represented on Plates I. and II. by γ_1, γ_2, γ_3, γ_4, and γ_5. Their atomic weights are 3, 51, 67, 99, and 115, respectively.

If any or all of these elements were mixed with I, its apparent

* Since the above was written D*i* has been found to be a mixture of two elements. See note on D*i*.

atomic weight would be reduced by an amount proportional to the quantity of the unknown elements and inversely proportional to their atomic weights. But the effect of each separately, and of all together, would be to *reduce* the atomic weight of I.

Consequently we find the atomic weight of this element, as determined by experiment, is much too low.

In the case of B*r*, however, γ_1, γ_2 and γ_3 would tend to reduce, while γ_4 and γ_5 would tend to raise the atomic weight. If all five were present in about equal proportions, the resultant would still be too low; not, however, so much as in the case of I; and this we find to be the fact, B*r* being three and I four units too low.

If these bodies really exist in B*r* and I, it is reasonable to suspect that C*l* may also be contaminated with some of them in very small, but nearly constant, quantities. The entire C*l* supply of the world comes practically from the sea, or from beds of rock-salt derived from the sea. On this account, if any of these unknown elements exist in any C*l*, they probably exist in all C*l* in about the same proportion.

It will be seen at once that all except γ_1 would raise the apparent atomic weight of C*l*. This gives a very satisfactory explanation of the irregular atomic weight of C*l*, it being .37 too high.

This .37 makes C*l* the only exception to Prout's law, and to the law of equicrescent valence between H and C*a*.

In view of these facts, does it not seem possible and even probable that some of these elements exist in C*l*, B*r*, and I; but are so closely related to them that it will require more delicate tests to distinguish them than any we have yet been able to apply?

The same argument will apply in exactly the same way to the K group, and with even greater force.

And may we not look upon Saxony lepidolite or rock-salt as a key which only awaits the hand of a Bunsen or a Kirchoff to unlock the whole mystery?

In this way I venture to explain the deviation of A*s*, S*b*, S*n*, C*s*, R*b*, Y, and of S*e*, if the atomic weight of the last element must be considered less than 80.

The broken curve shown on the plates passing through Ag^{+1}, Cd^{+2}, In^{+3}, Sn^{+4}, $Sb^{\substack{-3\\+5}}$, and $I^{\substack{-1\\+7}}$, indicates a nearly constant negative error of several units in the atomie weights of these elements.

Comment upon the deviation of *Yb*, *Sm*, and all other elements of doubtful atomic weight, is unnecessary, since their testimony is of little or no value one way or the other.

If we acknowledge $Cl = 35$, as explained above, it will involve changes in the atomic weights of many other elements. For instance, according to our best determinations* *Pt* would then be 192.5.

The deviation of *Ag* can be explained only by acknowledging it to have a maximum, $+3$, in sylvanite, $(AgAu)_2Te_3$.

We have, including those whose deviation can be explained, not less than *fifty-five* elements which bear testimony in favor of the law: five, *Mn*, *Cu*, *Zn*, *Cd* and *In*, which at present seem irreconcilable; and sixteen, columbium, decipium, didymium β, holmium, mosandrum, philippium, rogerium, terbium, thorium, thulium, yttrium β, osmium, thallium, gallium, praseodym and neodym, which cannot at present give testimony either way.

If we include *In* in this list of doubtful elements there remain only four obstinate ones, *Cu*, *Mn*, *Cd* and *Zn*.

We find additional proof of the existence of negative valence or "bonds" in reactions involving oxidation and reduction.

Whenever metallic bromides, iodides, sulphides, selenides, &c., are treated with powerful oxidizing agents, such as HNO_3, *Cl*, $HClO_3$, $HMnO_4$, &c., the first effect is the separation of the bromine, iodine, sulphur or selenium in the free state.

If the oxidizing agent is in great excess and is very powerful, the action will not stop here, but the free elements will be *further* oxidized to $HBrO_3$, HIO_3, H_2SO_4, and H_2SeO_4, respectively. I say *further* oxidized because the reaction is one of oxidation from the beginning. We cannot suppose that strong oxidizing agents always begin their action by ***reducing*** non-metallic elements to the free state and then re-oxidizing them to a higher degree. This is contrary to all our ideas of the nature of an oxidizing agent.

Besides, these same oxidizing agents ***never act that way upon metallic elements.*** If a metallic oxide is capable of being further oxidized, it is never reduced during the process to the free state by the substance which increases its oxidation. In other words,

* Seubert, *Chem. News*, 1888, page 51.

all non-metallic elements in binary salts are oxidized to ternary salts by passing through the free state; while metallic (electro-positive) elements never pass through the free state in the process of oxidation. This fact alone ought to suggest that the elements which pass through the free state (the necessary zero of valence) *change sign.*

We find ample proof of this in reactions involving oxidation and reduction.

The change of valence in oxidation can always be measured by the number of atoms of O or C*l*, or some equivalent element absorbed. For convenience in comparison we shall use the C*l* equivalent. We find it requires

6C*l*	equivalents	to change	bromides to bromates,
6C*l*	"	"	iodides to iodates,
6C*l*	"	"	chlorides to chlorates,
8C*l*	"	"	iodides to periodates,
8C*l*	"	"	chlorides to perchlorates,
2C*l*	"	"	iodates to periodates,
2C*l*	"	"	chlorates to perchlorates,
5Cl	"	"	bromine to bromates,
5C*l*	"	"	iodine to iodates.
5C*l*	"	"	chlorine to chlorates,
7C*l*	"	"	iodine to periodates,
7C*l*	"	"	chlorine to perchlorates,
8C*l*	"	"	H_3As to H_3AsO_4,
8C*l*	"	"	H_3Sb to $HSbO_3$,
6C*l*	"	"	H_3As to H_3AsO_3,
6C*l*	"	"	H_3Sb to $HSbO_2$,
2C*l*	"	"	arsenites to arsenates,
2C*l*	"	"	antimonites to antimonates,
3C*l*	"	"	A*s* to arsenites.
3C*l*	"	"	S*b* to antimonites,
5C*l*	"	"	A*s* to arsenates,
5C*l*	"	"	S*b* to antimonates,
8C*l*	"	"	sulphides to sulphates,
8C*l*	"	"	selenides to selenates,
8C*l*	"	"	tellurides to tellurates,
6C*l*	"	"	sulphides to sulphites,

6C*l*	equivalents to	change	selenides to selenites.
6C*l*	"	"	tellurides to tellurites,
2C*l*	"	"	sulphites to sulphates,
2C*l*	"	"	selenites to selenates,
2C*l*	"	"	tellurites to tellurates.
4C*l*	"	"	sulphur to sulphites,
4C*l*	"	"	selenium to selenites.
4C*l*	"	"	tellurium to tellurites.
6C*l*	"	"	sulphur to sulphates.
6C*l*	"	"	selenium to selenates.
6C*l*	"	"	tellurium to tellurates.

These facts are too well known to need further authority, and may be found in the equations of any treatise on chemistry.

C*l*, B*r* and I are acknowledged to be monads in all chlorides, bromides, and iodides; pentads in all chlorates, bromates, and iodates; heptads in perchlorates and periodates. If the valence of C*l* is $+1$ in chlorides, $+5$ in chlorates, and $+7$ in perchlorates, the difference between its valence in chlorides and in chlorates would be 4; chlorides and perchlorates, 6.

But we find from the above list that these differences, as found by experiment, are respectively 6 and 8 instead of 4 and 6. We are forced to the conclusion, therefore, that the valence of C*l* in chlorides is not $+1$ but -1, which makes the differences 6 and 8 as required.

The same is seen to be true of all the elements enumerated above.

What further proof do we need of the existence of negative valence?

The validity of the hypotheses and arguments given above evidently rests upon the truth of the general considerations which have led to the adoption of our present atomic weights. The conclusion reached is, therefore, an expression of these considerations.

Burlington, Ia., Oct. 10, 1885.

Iodine in Blowpiping.

By H. A. WHEELER *and* C. LUEDEKING.

The first application of iodine in blowpiping was made by Bunsen (Ann. Chem. & Pharm., vol. cxxxviii.) in 1866, who used the iodine as a secondary reagent. He first obtained, as is well known, the oxide films on a porcelain dish and then converts these into the iodide films by means of hydriodic acid. As a direct reagent we find iodine first used by von Kobell (Journ. Prakt. Chem., vol. cxii.) in 1871, for the detection of bismuth and lead, in the form of bismuth flux.* In 1883 Dr. E. Haanel (vol. i. Proc. Roy. Soc. Canada) made a great step forward by using hydriodic acid directly.

As performed by Dr. Haanel, he moistens his substance with hydriodic acid on a suitable support and then gently heats, when he obtains the volatile iodides of the more fusible metals. By this direct application he is able to secure several new reactions in addition to those of Bunsen.

As these iodides generally have very characteristic and striking colors, it becomes a valuable method for distinguishing as well as detecting very small quantities of these substances.

The hydriodic acid is prepared by passing sulphuretted hydrogen gas through water having in suspension iodine in excess, according to the well known method. If this reagent is used on the charcoal support, only partially satisfactory results are obtained, on account of its almost absolute nonconductivity of heat, while its color not only makes a poor background to show off the coats, but also compromises and modifies the true tint.

If, however, we take thin tablets of plaster of paris, we have a substance that rapidly chills and condenses the volatile iodides, while the pure white background not only shows the slightest amount of coloring matter, but also shows it in its true color. These tablets are made by pouring a thin mixture of plaster of paris and water upon a smooth flat surface, preferably a glass plate,

* Bismuth flux consists of a mixture of equal parts of flowers of sulphur and iodide of potassium.

and allowing it to set. Before perfectly hard it is cut into convenient pieces, about 4 inches long by 1½ wide, with a knife or spatula, cutting it while moist to prevent the breakage of the sheet if attempted when dry. Before the liquid plaster is poured on the flat surface, this must be very slightly oiled to prevent adhesion. (But little oil should be used lest the plaster turn black by its charring.)

The substance is placed on one end of these tablets, moistened with a few drops of the hydriodic acid and then gently heated in the oxidizing flame. It is necessary to use the oxidizing flame to prevent the deposition of soot, which interferes and tends to mask the films if the reducing flame is employed.

The hydriodic acid converts most of the metals into iodides, which, on account of their volatility, pass off in vapor on heating and are condensed as colored coats on the further end of the tablet. The beginner must not confound the brownish coat that is given off by the decomposition of the hydriodic acid itself; this brownish iodine coat will completely volatilize on standing a few minutes, especially if breathed upon.

The color of the coats produced by the different metals and metalloids are herewith described.

COLOR OF THE IODIDE COATS.

ARSENIC—A reddish-orange.

LEAD—A chrome-yellow.

TIN—A brownish-yellow.

SILVER—A bright yellow while hot; faint grayish-yellow when cold; is close to the assay.

ANTIMONY—An orange-red.

MERCURY—Scarlet and yellow, the yellow changing completely to scarlet on standing.

SELENIUM—A reddish-brown.

TELLURIUM—A purplish-brown.

BISMUTH—A chocolate-brown fringed with red near the assay.

COBALT—A greenish-brown edged with green; the brown color is evanescent, changing into faint green, especially when breathed upon.

MOLYBDENUM—A deep ultramarine; is close to the assay, and is the permanent oxide Mo_2O_5.

WOLFRAM—A faint greenish-blue; is a permanent oxide, Wo_2O_5; is close to the assay, and is brought out stronger by dropping on more acid after the operation.

COPPER—White.
CADMIUM—White.
ZINC——White; is very volatile.

As the copper, cadmium and zinc iodides are white, the tablet should first be coated with a film of soot, by holding it in a smoky flame, in order to give a black background to show off these white coats.

These three white coats closely resemble one another in their properties, and in order to distinguish them it is necessary to blow on them vapors of ammonium sulphide, when they are converted into their sulphides, and consequently will turn black in the case of copper, yellow with cadmium, and remain white with zinc. The copper iodide also gives the characteristic bluish-green color to the flame as it passes off, so that it can be readily determined even in the presence of zinc and cadmium.

If to the peculiar velvety-appearing chocolate-brown coating of bismuth a drop of dilute ammonia be added, or ammonia vapors be blown over it, the brown disappears, leaving a brilliant red coat.

Many of these coats are more or less evanescent, and disappear on prolonged exposure at ordinary temperature.

These coats will be found to be very striking and characteristic, and are very delicate, when compared with the usual blowpipe tests. It will be furthermore observed that we are now able to distinguish tin and zinc in the presence of each other, which has hitherto been impossible with the blowpipe alone.

In the case of complicated mixtures, the above metals cannot be satisfactorily distinguished from one another by this reagent, and it will not answer as a substitute for the old method, that necessitates a separation of them into groups. But for individual cases and confirmatory tests, especially when delicacy is required, it will be found to be a most valuable acquisition to the blowpipe outfit.

In the course of some experiments on these iodide reactions it occurred to the writers that they could be as satisfactorily produced by the use of tincture of iodine. On following up this idea with a series of tests it was found that the tincture was quite as satisfactory as the hydriodic acid, while it has the great advantage of being a reagent that is easily and cheaply prepared, and does not decompose on standing like the hydriodic acid. It is made by simply dissolving the iodine in alcohol to saturation.

Later, Mr. P. Cassamajor (Chem. News, 52, 1–2) showed that silver iodide, when properly manipulated, will also reproduce the iodide coats. While this is a further step in advance, in that it substitutes a solid for a liquid reagent, which is so very desirable in blowpiping, it requires careful manipulation, and is rather an expensive reagent.

Further investigation by the writers has shown that the simple dry iodine scales, as ordinarily found in the market, will give these reactions quite perfectly if the metals are present as sulphides, while, if we first mix the other compounds of the metals with flowers of sulphur and then add the iodine scales, we are able to bring out the reactions under all circumstances.

It suggested itself that a simple fusion be made of this mixture of sulphur and iodine, thus obtaining the two elements thoroughly intermixed in their proper proportions. Thus a brown mass results of iodide of sulphur, which, when powdered, does not volatilize or decompose on exposure, while it is now in very convenient form for immediate use.

The proportion found to be best adapted for general application was 40 per cent. of iodine and 60 per cent. of sulphur. This iodide of sulphur is mixed in excess with the substance to be examined and then treated on one end of the tablet with the oxidizing flame, when the same results are obtained as before. This simple solid iodide of sulphur gives the reactions with the same clearness and delicacy as the hydriodic acid. It was by the use of the iodide of sulphur that the original tablets were made from which the plates 11, 12, 13, herewith appended, were prepared.

On referring to plate 11, the mercury coat as shown is the result of standing several minutes ; when fresh, as first obtained, the outer coat is yellow, but changes to red on standing.

On plate 12 is shown the bismuth coat before and after treatment with ammonia vapor. The lead coat on plate 12 is, perhaps, more generally a simple yellow than the reddish-yellow as represented.

On plate 13 is shown the cadmium coat before and after treatment with the vapor of ammonic sulphide. The blue molybdenum coat is not an iodide, but the pentoxide, and is permanent. The coat as given by the simple iodide of sulphur is also shown (plate 13), which for an instant or so is apt to mask the iodide coats, but it disappears completely on a few minutes' exposure.

It will be noted, that close to the assay in the tablets illustrated there is more or less of a black film, due to the formation of sulphides from the excess of sulphur that is requisite to insure the decomposition of all compounds.

As one of the most valuable features of the blowpipe outfit is portability, and as liquids are most undesirable members in a traveling outfit, we have now secured the benefit of the very delicate and valuable reactions of the iodides in this cheap and simple reagent.

Laboratory Washington University, May, 1886.

PLATE II


ARSENIC.


THALLIUM.


SILVER.


MERCURY.


ANTIMONY.

PLATE 12

BISMUTH.

BISMUTH.
Treated with Ammonia.

SELENIUM.

LEAD.

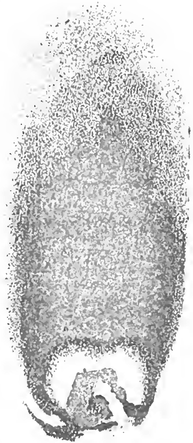
TIN.

PLATE 13

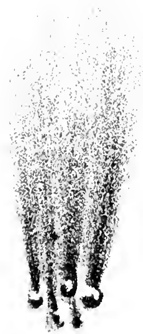
CADMIUM.
Treated with Ammonic Sulphide.

CADMIUM.

TELLURIUM.



MOLYBDENUM.



IODINE.

GENERAL INDEX.

☞ *The italic figures refer to the Proceedings.*

ERRATA.

Page lxxxv., Proceedings of April 20, 1883, for "$y = x$" read $y = x^n$.

Page cclxvi. of Vol. III., line 6. after "Washington" add University.

PROCEEDINGS.

January 7, 1878.

The President in the chair. Twenty-eight members present.

O. W. Collet presented a copy of Faraday's Chemical Manipulation.

Mr. Riley read a paper on "Water and Land Mites," which was referred to the Publication Committee.

Mr. Riley remarked also in reference to the little acorn gall, recently described by him as *Quercus glandulus*, that it is referred to by Mr. Emerson in the new edition of his "Trees and Shrubs of Massachusetts," in speaking of *Quercus prinoides*, in the following words: "The cup is often set with several abortive acorns, which fall out when about one-fourth of an inch long." This is but a further illustration of the fact that the gall is so very generally mistaken for an abortive acorn by otherwise excellent authority.

Mr. C. V. Riley, the retiring President, then delivered the following

ANNUAL ADDRESS.

Gentlemen and Fellow-Members of the Academy:

Once more it becomes my privilege and pleasure to greet you at the dawn of a new year. We commemorate to-day the twenty-second anniversary of our existence as an Academy, and, upon retiring from the chair with which you have for the second time honored me, I am led, both from a sense of duty and from precedent, to offer you a few suggestions. These must take the form of a report rather than an address, for I shall not detain you by attempting to review the general progress of science during the year that has just closed, nor to even mention some of its salient features as I did a year ago. I wish rather to dwell briefly on a few local matters that more particularly concern us.

MEMBERSHIP.

We have now 110 Associate Members in good standing, an increase of one since our last annual meeting. During the year 24 new members were elected, 7 of whom have, however, not yet paid their initiation fee, and are not, in consequence, included in the above estimate. We have also 2 Life and 143 Corresponding Members.

FINANCES.

We lost, fortunately, but about $15 by the failure of the National State Bank of Missouri, with which our funds were deposited, and the Treasurer's Report shows that $547.45 have been collected and $680.61 paid out. The bulk of this sum was for the publication of our Transactions, $100 of it being, however, to the Archæological Section for mound explorations in Southeast Missouri. This leaves a balance of but $26.25 in the treasury, and there are yet outstanding bills of the R. P. Studley Company, for publishing Transactions, to the amount of about $400.

We have so far paid for the publication of Vol. III. of our Transactions without extraneous assistance, the funds being derived from the initiation fees and annual dues. Our active membership is very limited, but there is, fortunately, a large number who give us their support by the prompt payment of their annual dues, and thus enable us to continue publishing. The few on whom the labor of contributing to and preparing the Transactions directly falls have been in the habit of also partly defraying the expense of publishing their individual contributions. I sincerely hope that the balance now due the publishers on Vol. III., just completed, will at once be made up by volunteer subscriptions.

TRANSACTIONS.

Our credit, and our existence even, outside of St. Louis depend almost entirely on our published Transactions and the intrinsic value of their contents. It gives me great pleasure, therefore, to be able to announce that we have published No. 4 of Vol. III. during the year, and have thus just brought the volume to a close. Aside from minor communications, we have published an elaborate paper by Prof. Seyffarth on the Theory of the Moon's Motions; one on Mound Exploration by Mr. Croswell; several valuable Botanical papers by Dr. Geo. Engelmann, and several Entomological papers.

ARCHÆOLOGY.

The Archæological Section has been active during the year. Field work has been carried on in Southeast Missouri, Northern Arkansas, and Illinois. Surveys have been made of several groups and photographs obtained of the "Monks' Mound Group" in Illinois. Valuable additions have been made to the collection, which consists now of 528 pieces of pottery, 35 skulls, besides a large number of bones, one engraved shell, and many stone implements. The first memoir on "Missouri Pottery," richly illustrated with lithograph plates, will be ready for publication probably early in the spring. Communications have been established and exchanges arranged with many of the archæological societies as well as the principal museums in this country and some in Europe.

A. A. A. S.

In August next, the American Association for the Advancement of Science will for the first time meet in St. Louis — an event, let us hope, that will be fraught with beneficial results to science and add to our local interest in her advancement. It behooves us, as an academy, to at once take steps to perfect the preliminary arrangements. There should be formed with as little delay as possible a local committee, consisting of chairman, secretary and treasurer, which should enter into correspondence with the Permanent Secretary of the Association, Mr. F. W. Putnam of Salem, Massachusetts. A committee at large of twenty or thirty prominent citizens should also be formed with sub-committees on reception and accommodation, finance, excursions and railroads. As an academy we should feel a certain responsibility in this work, and I recommend the immediate appointment of a committee to take this matter into consideration and arrange with members of the Historical Society, Chamber of Commerce, Board of Public Schools, city government, etc., to call a meeting for the purpose of organization. During the past ten years I have attended no meeting of the Association that has not produced beneficial results among the entertainers, and let us strive to make its next meeting worthy of and creditable to St. Louis.

LIBRARY.

Our library annually increases with the addition of valuable exchanges from scientific bodies the world over. It forms, indeed, the only extensive scientific library in the city. Under these circumstances I regret very much to be unable to report any more favorably than I did a year ago as to the care and condition of the publications that have been added during the past few years. Our present Librarian informs me that none of the accessions since October, 1876, have even been entered, so that it is almost impossible to consult any of the more recent publications. There is an evil here that needs remedying, and it seems to me that we must go to the root of it.

Our contract with the Public School Board requires us to do our own classifying and cataloguing, or, at least, that it be done under our direction; and as a means of accomplishing this we have been in the habit of appointing as our librarian the person employed in like capacity by said Board. It was expedient to do so under the circumstances, and it has been our misfortune that the appointees have not sufficiently appreciated the responsibility and labor which the acceptance of any position within the gift of the Academy necessarily brings. The plan which we have recently adopted of placing the exchanges for the current year in a separate case on the main floor of the library building will partially remove the evil here referred to, and I would recommend, for its thorough removal, that the next Library Committee confer with the Board of Public Schools with a view to some modification of our agreement that will insure the proper arrangement and care of our books and pamphlets in future.

BUILDING—MUSEUM.

By the terms of the deed, the Lucas lot, donated conditionally to the Academy and to the Historical Society, virtually passed from our possession last June, and all efforts to get the heirs to make an unconditional donation of it have proved unavailing. It will, I think, be best to formally renounce all claim to the lot, and thus avoid incurring a fruitless taxation. Here let me emphasize all that I said a year ago as to the vital importance to us of a permanent building for our museum and library.

I would urge in addition that a taste for natural science is largely due, in any community, to the stimulus afforded and interest excited by a museum. Our older members are gradually passing away. Where are the young naturalists to take their places? As a city, St. Louis is lacking in specialists in natural science to a remarkable degree, and we can no longer find among our own members specialists enough to frame the standing committees on ethnology, embryology, comparative anatomy, mammalogy, ornithology, ichthyology and erpetology, geology and palæontology, chemistry, etc. This state of things would not long exist with a well kept museum and library to lead and encourage the youth so inclined into the pleasant, elevating and refining paths of natural history.

Early in the year a special meeting of some of the members was held, to consider the best means of raising funds for a building, but all effort was for the time abandoned on account of business depression. With indications of improvement in this respect, with the increased interest in our work that may be looked for in the community from the meeting with us of the American Association, the time seems to me ripe for renewed endeavor. I have always believed that with proper effort the citizens of St. Louis would not remain blind to our requirements. Davenport, Iowa, is about to dedicate a building to the service of science, and the funds to erect it were obtained almost solely by the persistent efforts of a single lady. I would suggest the appointment of a committee of five or ten members to prepare printed subscription blanks, to be headed by subscribers from among our own members, by means of which to make a steady and continued appeal to our citizens until a sufficient sum is subscribed. We have been expecting and hoping ever since we had an organization, that some wealthy citizen, having a due appreciation of the importance of science and of the aims and objects of the Academy, would generously help us out of our discouraging financial straits; but such aid need hardly be looked for till we have made a start through our own efforts.

METEOROLOGY OF THE YEAR.

The meteorological peculiarities of the year have been somewhat striking. While the spring and summer throughout most of the Mississippi Valley was unusually wet, a very severe and disastrous drought prevailed in Southern California, and a less severe one in the more northern States from Minnesota to the Atlantic. The mean temperature at St. Louis, as shown by Dr. Engelmann's records, has been about the average for forty-two years, the lower temperature of nine months being counteracted by the higher temperature of February, October and December—a striking illustration of the greater value of extremes as conveying useful information than of mere averages. The month of December was remarkable as having a mean temperature of 13.2 degrees higher than the average for forty-two years, and 4.9 degrees higher than the next warmest (1875) during that period. Dandelions and many other spring flowers were in bloom in the woods, and it is worthy of remark in this connection that similar unseasonably warm December weather obtained in England and other parts of Europe.

The Weather Service, started the first of last month by one of our members, promises well. It is intended to develop this weather service into a bureau of useful information; to train persons in each county in habits of observation, to whom the entomologist, botanist, etc., may look for much valuable information. To do all this will require time and a great deal of work on the part of the director, Prof. Nipher. At the central station, at Washington University, observations will be made as complete as possible, as well on the general meteorology of our State, as on terrestrial magnetism and atmospheric electricity, ozone, and sunspots.

CONCLUSION.

It is now nearly twenty-two years since a few zealous citizens interested in natural science met together and organized this association, and we may well feel proud that some of those original founders of the Academy are among our most active working members and most constant attendants at our meetings. At times, no doubt, well nigh discouraged, these faithful members have stood steadfastly by the Academy where so many have forsaken it. May they be inspired to continued aid by the assurance that, as time rolls on and the Academy grows in power and usefulness, their names will shine with still increasing lustre, and future members will look back with reverential feeling to those who, by their investigations, their self-sacrifices, and their unswerving constancy, did so much, not only to give birth to the Academy, but to carry it through the struggles of infancy. While I have freely pointed out some of the faults we suffer from in the hope that they may be remedied, I by no means forget that we have much to be grateful for. When we recall some of the dark years of war, debt, and misfortune—when we reflect that between 1868 and 1873 we were unable to publish anything, we may well congratulate ourselves that we are progressing, surely, if slowly. While the country has passed through five years of unexampled depression in all departments of industry, the advance of science has not been impeded, and through it all the Academy has accomplished more than during the previous years of national prosperity. Two of the most despotic nations of the East have, during the year, begun, and are still carrying on, a cruel and devastating war; yet both France and our own country—to the glory of republics be it said—have peaceably settled civil strifes that threatened to end in revolution and all its attendant carnage and misery. The signs of the times point to a returning period of business activity in this country, and let us hope for and work for a share in the general prosperity, that we may leave to those who come after us an academy firmly rooted in public favor, and permanently established in location and equipments.

During the summer, official duties prevented my being with you as often as I could have wished; and here let me say that the investigations into the Rocky Mountain locust scourge by the Commission appointed for that purpose, last spring, have been fruitful and satisfactory beyond my most ardent hopes. Many mysteries regarding it have been fully cleared up, and we have learned enough to feel that it is measurably within man s control. With another year's investigations we shall be able to accomplish all that human investigation can well accomplish, and be better prepared for any future irruption.

In conclusion, gentlemen, permit me, in giving way to my successor, to sincerely thank you for the uniform indulgence which I have never failed to receive at your hands.

The Academy then listened to the annual

REPORT OF THE CORRESPONDING SECRETARY.

During the year seven additional societies have been added to our foreign exchange list, and four to the home list. The foreign list now comprises 235 names, and the home list 107 names. The exchanges we are annually receiving from all correspondents, are making a constant and valuable addition to our library, which at the present time contains doubtless the largest collection of scientific publications to be found in the Mississippi Valley.

The list of Corresponding Members at the present time comprises about 132 names. Two names have been added during the past year.

The election of officers for the ensuing year was then held, with the following result:

For President—Geo. Engelmann.
First Vice President—C. V. Riley.
Second Vice President—Silas Bent.
Treasurer—Enno Sander.
Corresponding Secretary—Nathaniel Holmes.
Recording Secretary—Francis E. Nipher.
Librarian—Fred. M. Crunden.
Curators— G. Hambach, Geo. J. Engelmann, Fred. F. Hilder.

Dr. Jno. Goodin was elected to associate membership.

January 28, 1878.

The President, Dr. Engelmann, in the chair. Twelve members present.

Dr. Engelmann read the following communication on

THE TEMPERATURE OF DECEMBER, 1877.

The unusually warm weather of last December has attracted very general attention, and justly so. Its mean temperature was at my station 46.8 degrees, which is 13.2 degrees higher than the average (33.6) of 42 years, 23.5 degrees higher than the coldest December we have had (23.3 in 1872 and 1876) and 4.9 degrees warmer than the warmest December (41.9 in 1875) I had before experienced here. A singular coincidence, if merely coincidence it is, strikes every one here. Some of the warmest and coldest Decembers of 42 years are crowded together within the short space of 6 years, and within the last 3 years we have had one of the coldest between two of the warmest Decembers.

December having been so unusually warm, what may be inferred in regard to the temperature of the balance of the winter? In answer I have nothing to offer but the experience of former years.

The last one was the fourth December in 42 years, the mean temperature of which rose above 40 degrees. The following table will show the temperature of the warm Decembers and of the three succeeding months:

Dec., 1857, 40°.5	Jan., 1858, 40°.5	Feb., 1858, 27°.2	Mar., 1858, 47°.8
" 1862, 41°.4	" 1863, 37°.4	" 1863, 35°.8	" 1863, 43°.7
" 1875, 41°.9	" 1876, 39°.4	" 1876, 39°.3	" 1876, 38°.3
" 1877, 46°.8			
" aver'ge 33°.6	" aver'ge 31°.7	" aver'ge 35°.5	" aver'ge 43°.4

It is here seen that, after an unusually warm December, January was always from nearly 6 to nearly 9 degrees warmer than the average; February was once colder, once warmer, and once about equal to the average; March was once warmer, once colder, and once equal. We may expect therefore, judging from past experience, a mild January (which does not mean that an occasional fall of the thermometer below zero may not take place), a doubtful February, and, if both be mild, possibly a cold March and a late spring.

Just as December was so much warmer than usual, so the vegetation became more spring-like; there were many early blooming trees and shrubs — so early, in fact, as to threaten the destruction of their flower-buds.

Dr. Engelmann read the following note on

THE METEOROLOGY OF THE YEAR 1877.

The whole year 1877 had about the mean temperature of 42 years, viz., 55.3 (mean 55.4), notwithstanding that we had in nine months a lower temperature than usual. January, April and May were between 2 and 3 degrees and March nearly 6 degrees below the average. But the three warm months of February, October and December brought the average of the year up to the normal point—a striking instance, by the way, how little real information mere averages give us about meteorological conditions.

The number of days on which it rained, 114, is scarcely more than the average, and the quantity of rain, 37.20 inches, is less; the largest quantity fell in June, and next in March and October—the least, as usual, in January and February; in all the other nine months the quantity of rain varied between 2 and 4 inches.

Vegetation was retarded nearly two weeks by the cold weather of spring, but thus it happily, to a great extent, escaped injury by the frost, which visited a part of the State in the night of April 29th–30th. With the exception of this slight injury, the season was an unusually favorable one for the agriculturist, and as favorable also for the health of the people; owing, no doubt, to the moderate degree of summer heat and the pretty uniform distribution of rain.

Mr. H. T. Woodman of Dubuque was introduced to the Academy, and exhibited the following specimens: 1. Halysites from the Niagara group of Jones Co., Iowa, with rays well preserved; 2. a specimen of coral, which on the one side is a rayed *favosites*, and on the other side *columnaria*, seeming to show that these two corals are identical.

Prof. W. B. Potter exhibited a specimen of spiegeleisen from the Vulcan Iron Works, showing a large coating of graphitic carbon. Nearly all the fragments of spiegeleisen had the same coating. Analysis showed, as was suspected, the presence of a large quantity of silicon, 1.181 per cent. having been found. Prof. Potter remarked that he had never before discovered more than one-half per cent. of silicon in spiegeleisen. The specimens analyzed contained—of carbon, 4.7 per cent.; of graphitic carbon, 0.549 per cent.

Mr. F. F. Hilder presented to the Academy, in behalf of Mr. H. T. Woodman, a specimen of flexible coral (*Gorgonia anceps*). A vote of thanks was tendered to Mr. Woodman.

February 4, 1878.

Dr. G. Engelmann, President, in the chair. Twenty members present.

Mr. Collet made some remarks on the efforts of Lord Bute to domesticate the beaver, and to establish, by the exclusion of all disturbing agencies, a rendezvous for wild animals and fowls.

Dr. Stevens presented for inspection several specimens of bone phosphates from South Carolina, and some fine crystals of native calcium oxalate.

Dr. Engelmann called attention to Paris meteorological records of June last, pointing out that in different parts of the city differences of temperature of 18 degrees were observed.

February 18, 1878.

The President in the chair. Twelve members present.

In behalf of Mr. Wm. Einstein, Dr. Engelmann presented several specimens of ore from the silver mine in Madison Co., Mo., on the St. Francis river. The specimens included syenite — in which the vein occurs,—wolfram, pyrite, and many pieces of argentiferous galenite. The specimens were accompanied by a diagram of the mine.

Judge Holmes called the attention of members to the recent work of Dr. Paul Topinard on "Anthropology," with a Preface by Prof. Paul Broca; translated by R. T. H. Bartley, M.D.; London, 1878.

This is a highly important work, especially for practical observers, and is probably the best extant summary of the present state of the science. It explains fully the modern methods of measurement as adopted by Dr. Broca and other distinguished anthropologists, and must become an indispensable handbook for the practical observer.

As among the more interesting conclusions of the learned author, I may mention the following. The Pliocene man of the flint implements of St. Prés, in France, hunted the *Elephas meridionalis*, the *Rhinoceros etruscus*, the *R. Merckii*, and the *R. leptorhinus*. At the close of the Miocene period, as shown by the shell-heaps of Pouance, Man was in conflict with the Mastodon and Halitherium, and possessed the knowledge of fire. The worked flints of Thénay, found by the Abbé Bourgeois, are assigned to the Lower Miocene, below the La Beauce chalk. Man's existence, at that epoch, "is a clearly revealed scientific fact."

The Neanderthal skull and the skulls of Canstadt, Eguisheim, Brux, Denise, L'Olmo, and Clichy, are compared, and found to belong to the oldest people, whose bones have been yet discovered in France, called the *Race of Canstadt.* They were both dolichocephalic and platycephalic. They exhibit much resemblance to the skulls of the anthropoid apes. The superciliary arches of the Neanderthal skull are said to be "altogether simian," though clearly a human skull. Its capacity is found to be 1200 cubic centimetres, that of the average European being from 1550 to 1600 c.c., and that of the Australian 1295 to 1347 c.c. A jaw of this race from Naulette is prognathous, but has neither chin nor tubercles *géni.* This flat-headed race is supposed to have lived contemporaneously with other and superior types as a survival of an older and inferior type. The author is not prepared to say whether, on the whole, this Neanderthal skull approaches nearer to man than to the anthropoid ape.

A small number of Brachycephals appeared in France at the close of the Palæolithic epoch. Next, there was an invasion of Dolichocephals from the north, and then of Brachycephals, at the close of the Polished-stone epoch, along both sides of the Alpine range, and some mixture with the earlier races is supposed to have formed the Celtic type of central France.

The author follows the classification of Dr. Paul Broca, making five *Families* of the Order PRIMATES: 1. Men; 2. Anthropoid Apes; 3. The Pithecians; 4. The Cebians; and 5. The Lemurs.

He concludes that the Human Family is composed of distinct species, of which he ventures to define three as follows:

I. Brachycephalic, of low stature, yellowish skin, broad and flat face, oblique eyes with contracted eyelids, hair scanty, coarse, and (in section) round.

II. Dolichocephalic, tall stature, fair complexion, narrow face, projecting on the median line; hair abundant, light colored, soft, and (in section) elliptical.

III. More dolichocephalic, black skin, hair flat and rolled into a spiral, very prognathous, radius long, buttocks prominent, breasts (in female) elongated.

The *Berber type* is considered as composed of a brown autochthonous groundwork and a mixture with northern blonde whites, eastern Arabs, and southern negroes; the autochthonous stock being probably the offspring of some more general types of which we have no knowledge.

Perhaps we might infer that the author's view was, that the brown type was formed by an admixture of the yellow or white with the black species. Though this may be very possible, it would seem to be worthy of consideration that in a general view and in reference to the geologico-geographical distribution of the human races, the brown or reddish-brown color appears, on the whole, to occupy an area of the globe lying between the yellow and white races on the north and the black race on the south, in respect of their original habitat. And it would seem to be probable that a brown type existed contemporaneously with the yellow and black types at the earliest period of the evolution of the human races.

This matter of the geologico-geographical distribution, not specially examined in this work, would seem to be of great importance. Geography gives the distribution in space; geology, the distribution in time. They are necessary coördinates. Mr. Wallace has made a valuable contribution in reference to all classes of animals except Man: the like work remains to be done with regard to the human races.

Dr. H. Kinner exhibited a live specimen of Menobranchus, found in the Mississippi river at this place, and thought it might be a new species. This idea was based on the markings of the animal. This decision was called in question by Mr. Riley, who remarked that it was well known that great changes occur in the life history of these animals. The present markings may change for others, and further observation would be desirable.

Mr. H. W. Leffingwell was elected to associate membership.

March 4, 1878.

The President in the chair. Seventeen members present.

The Corresponding Secretary presented a paper from Dr. G. Seyffarth on Egyptian Theology, which was referred to the Publication Committee.

Mr. Collet presented the Academy with an American edition of Weisbach's Mechanics and Engineering. 2 vols. Philadelphia, 1848.

Mr. J. A. Dacus presented a lithograph received from Don Antonio de Corruna, of Santo Domingo, Chiapas. The lithograph represents the ruins of a vast palace at Xayi, Chiapas, Mexico. Mr. Dacus read, from an accompanying letter, of some remarkable discoveries recently made in this palace. In subterranean chambers of the ruins, a prodigious number of terra cotta tablets were discovered, each eight inches long, six inches wide, and half an inch thick, covered with characters, which, from the regular and frequent occurrence of the same graphs, appear to be alphabetic. Prof. Pimentel, of Mexico, to whom some copies taken from the tablets were submitted, expressed a strong hope that these tablets would be speedily deciphered. The tablets are supposed to be part of a library, and Don Antonio de Corruna expresses the opinion that these tablets may be the original of the Popol Vuh, or sacred books of the Tzendal or Mayas.

Mr. Crosswell exhibited a specimen of blind fish from the Mammoth Cave, Kentucky.

Mr. J. O. Broadhead presented a section from the trunk of a Yucca from Mohave Desert, California. This plant is used quite extensively in that region for the manufacture of paper. Dr. Engelmann stated that he had described this plant in the Transactions as *Y. brevifolia;* the California papers speak of it erroneously as *Y. Draconis.*

Dr. Engelmann read the following note on

THE TEMPERATURE OF THE WINTER OF 1877-8.

As we had reason to expect from the high temperature of December, January turned out mild, and February also had a much higher than the average temperature. Thus the whole winter was a very mild one; but it was not, as has been said, the mildest in the memory of man, for we have had, since I began to make observations, two other winters even a little milder than the past one. The mean temperature of March was 40°, which is 5° higher than the average. Warmer Februaries (between 40° and 44°) were observed in 1844 and 1845 (two years in succession), in 1848 and 1857; and it is interesting to note that in the three years first mentioned, March was also warmer than the average, but in the last year, 1857, it was 4 degrees colder than the average. As a rule, we may assume that a warm March follows a warm winter. Our mean winter temperature is 33°.4, and only three times it reached from 40° to 40°.4, viz. in the winter of 1844-5, 1875-6, and the past winter. Mark here that we have had two very mild winters within three years.

I wish to direct attention to the fact, that the winter temperature was more even than usual; that we had no sudden changes, such as occur so often in our inland climate.

The lowest temperature of December was 19°, of January 7°, of February 18°, all above zero; while the highest of December was 69°, of January 54°, of February 60°.

On the first of the warm winters mentioned above, the temperature never fell below + 10°, but in the second it fell to — 2°.

I find 11 winters in 43 in which the temperature did not fall below zero in St. Louis, and three times it fell below —20°.

The coldest winters I have experienced here, were those of 1855–6, with 26°.4; 1871–2, with 29°.1; 1872–3, with 26°.3, and 1874–5, with 26°.9. Thus we have had some of the warmest and some of the coldest winters within the last seven years.

Mr. Nipher presented a rain-chart of the State for February, 1878.

March 18, 1878.

The President in the chair. Twelve members present.

The Corresponding Secretary read a letter from Mr. J. Cochrane, of Havana, Ills., relating to large mounds located near Havana. The writer gave a general description of the location and size of the mounds.

Dr. Sander gave some account of the explorations of Dr. Gerhard Rohlfs.

Dr. Engelmann presented a chart showing his observations for 42 years, on the advancement of spring as shown in the development of vegetation.

Among the plants observed were the American elm, soft maple, apricot, peach, apple, crab-apple, quince, black locust, catalpa, and the wheat and oat harvests. The observations showed that, thus far, the present spring is the earliest for 45 years. The springs nearest the present were those of 1842, '45, '51, '58, and '71. Sometimes early development was checked by later frosts, a remarkable instance of which occurred in 1834 (April 27th), when apples as large as marbles, and new shoots of hickory and oak, several inches in length, were killed upon the trees.

While the spring of 1842 was one of the earliest, that of 1843 was one of the latest. In these two years, the time of wheat harvest shows a difference of about three weeks.

April 1, 1878.

The President in the chair. Twelve members present.

Mr. Collet presented the Academy with a copy of Knapp's Chemical Technology.

Mr. J. B. C. Lucas presented a fragment of a fossil bone, found on the headwaters of the Colorado river, in Texas. It was believed to be a portion of the fibula of a large tertiary saurian.

Dr. Engelmann read the following paper, comparing the present spring with that of 1842:

The extraordinarily mild weather of this spring, and the consequent early development of vegetation, merit a thorough consideration of these phenomena, and a comparison with the only other very early spring in St. Louis, since observations have been recorded, that of 1842.

The temperature of March, 1842, was 55°, which is nearly two degrees higher than that of the past March, which was 53°.2, and nearly twelve degrees higher than the average for March. February, 1842, was scarcely warmer than the average, and March was by no means warm in its first part, the temperature falling several degrees below the freezing point, every night, from the 11th to the 13th; but from the 16th on it began to rise, reaching between 70 and 80 degrees six times, and between 80 and 86 five times; while last March, my thermometer reached between 76 and 77 as the highest of the month, only three times. This accounts for the more rapid development of vegetation in the latter half of that month. The shad-bush (*Amelanchier*) was in full bloom on the rocky slopes between the Arsenal and Carondelet (where at that time it abounded) on the 18th. On the 19th I recorded plum and peach trees in bloom in the gardens in the city; on the following day cherry and pear trees were noted in bloom, and on the 21st the first blossoms were found on the two early apple trees in the bishop's garden, at the corner of Walnut and Second streets, which I used to observe every year as among the earliest in bloom. On March 26th the red-buds were seen in bloom in the woods; on the next day, the lilacs in the gardens showed the first flowers, and on the 28th the apple trees everywhere in the gardens in and about town were recorded in full bloom. On the last day of the month, lilacs were in flower in town, and paw-paws, black and red haws in the woods around, and dogwood began to show its conspicuous white flower-like involucral bracts.

It appears that this year we are a few days later, undoubtedly caused by the cooler weather since the middle of the month, though it was interspersed with a few warm days.

As it is, this March and that of 1842 were the only March months in 46 years in which the temperature rose to more than 50 degrees, and during which the peach trees passed their flowering periods and the apple trees and lilacs began to bloom.

Let us now look at the month of April, 1842, succeeding that early March. Its mean temperature was 63°, being seven degrees above the average, and although we have had several as warm Aprils, in none did the vegetation make such rapid progress, owing to the start it received in March. I will only state that my notes prove our wild crab-apple to have been in bloom on the 4th, quinces on the 5th, oak and hickory on our hills and the acacias, which were then more abundant in our streets than now, in full leaf on the 6th. Dogwood was in its fullest glory on the 7th. The first acacias bloomed on the 11th and their general blooming occurred on the 14th. On the 23d the garden roses began to flower, and our latest grape species, the summer grape, was then in full bloom. The first strawberries (wild ones) appeared in the market on the last day of the month. On the 1st of May I noticed green peas in the market, but on the 4th we had in open places out of town some white frost and thin ice, which, though it did not injure the fruit hereabouts, did some damage to tender garden vegetables, such as beans, cucumbers, and potatoes. The first ripe cherries were seen in market on the 13th, and the early catalpa bloomed (again in the bishop's garden) on the 14th.

I find in my records a memorandum that on June 11th snow and ice were seen in many parts of New York and Pennsylvania. With us the temperature of May was an average one, and that of June several degrees below the mean.

The succeeding year, 1843, was one of the eight coolest years I have observed here, and though the winter until the end of January was by no means very cold, and was even above the average, February and March were so cold that spring did not open until about a month later than in 1842, the elm not blooming before the middle of April, peach trees before the 25th, apple trees before the beginning of May, and acacias together with the first roses not until May 22d—all about one month later than in the preceding year. These, then, are about the limits of our earliest and of our latest springs, and the others range between those limits.

Dr. Engelmann also laid before the Academy a plate, showing several species of tulips, mostly natives of Asia, which are being introduced into English gardens.

April 15, 1878.

Dr. Engelmann, President, in the chair. Eleven members present.

Mr. Nipher referred to a simple method by which Prof. C. A. Smith of Washington University had determined the velocity of falling rain-drops. In the case examined, large drops were falling vertically. Riding rapidly in a horse-car, the drops appeared falling in inclined paths — the effect of aberration. It was only necessary to measure, on the vertical and horizontal edges of the car window, the lengths, which determined the angle of slant, and to determine the velocity of the car. The velocity of the drops proved to be about 14 ft. per second, the speed of the car being about 12 ft. per second.

J. Cochrane, of Havana, Ills., was elected to corresponding membership, and Prof. J. K. Rees, Robert Benecke, and Henry Michel, were elected to associate membership.

May 6, 1878.

C. V. Riley, Vice President, in the chair. Nine members present.

Mr. Nipher made a communication on the distribution of rainfall in the State.

The Secretary presented, on behalf of Mr. J. A. Dacus, a paper, entitled "The Zoque, the Language of Santa Maria de Chimalapa, in the State of Chiapas, in the Republic of Mexico," translated from a Spanish MS. by Señor Don Antonio de Coruna, by Joseph A. Dacus, Ph.D.

Mr. Ernst Olshausen was elected to associate membership.

May 20, 1878.

Dr. Engelmannn, President, in the chair. Twelve members present.

Mr. C. Crosswell read a paper on "Symbolism," followed by another on "The Sun-god of the Mound-builders." Mr. Crosswell pointed out similarities between the decorative forms on mound relics and those of ancient races of the old world, and argued a unity of origin.

Judge Holmes urged that the same decoration might originate independently in different nations, just as arrow-heads of stone are produced all over the world at certain stages of development, and that, in accounting for the presence of man on this continent, we must go back in geological time to a period when the configuration of the continent was quite different from what it is now.

Mr. Nipher stated that those who have examined the subject, claim that the arrangement of the muscles which move the eye, the anatomical and mechanical arrangement of the arm, the vertical position of the human body and of tree trunks, with many similar things, have great influence in determining the form of decoration, predisposing all human beings to draw certain lines.

Mr. Crosswell's papers were referred to the Pub. Committee.

Mr. Geo. C. Pratt read a communication on the stage of the Missouri River during the years 1853–55:

Having read with much interest Dr. Engelmann's notes on the different stages of water in the Mississippi River at St. Louis, recorded in vol. ii. of the Transactions of this Society, I have thought it not improper to submit the results of some observations of certain stages of the Missouri River at the City of Jefferson. These observations were made by myself while in charge of the construction of a part of the Missouri Pacific Railroad; they cover a period of two years, extending from July, 1853, to July, 1855, and were made with reference to a comparison with the high water of 1844. This last point was ascertained approximately by the remembered nearness of its approach to the top of the pavement in front of the old hotel at the steamboat landing of that day, and accurately by a mark made at the time of the high water with black paint on the perpendicular face of the rock bluff between the capital building and the river by a gentleman who went out in a boat with a brush and paint-pot for that purpose. This mark was seen by me in 1853, and its elevation taken with reference to a permanent point adopted as the base from which all the observations were made, and was about one foot below the present grade of the railroad at that point. The lowest stage of water found during the two years occurred Feb. 1st, 1855, which stage was regarded by observers of the river as exceedingly low, and is taken as the base of the following table showing the relative height of water at the dates given, viz.:

July (flood of), 1844	30′	10″	Sept. 1, 1854	6′	3″
" 1853	18	6	Oct. 1, "	5	6
Oct. 1, "	5	9	Nov. 1, "	5	0
Nov. 1, "	4	8	Dec. 1, "	4	8
Jan. 1, 1854	0	9	" 15, "	2	10
Mar. 1, "	6	3	Jan. 1, 1855	2	9
Apr. 1, "	5	9	" 10, "	3	6
" 10, "	7	2	" 20, "	0	10
" 20, "	11	1	Feb. 1, "	0	0
May 1, "	6	10	Mar. 1, "	2	3
" 10, "	6	6	" 10, "	2	10
" 20, "	10	3	Apr. 1, "	4	9
June 1, "	12	6	" 15, "	7	6
" 10, "	15	6	May 1, "	4	9
" 20, "	14	0	June 1, "	10	6
" 25, "	17	6	July 1, "	11	6
July 1, "	16	0			

It is very possible that the low water of Feb. 1st, 1855, here recorded, may not be the lowest ever reached by the river, but from my knowledge of the stream, extending through thirty-seven years, I am quite sure that it must be within a few inches of the minimum at that point.

The flood of 1844, therefore, which registered over 41 feet above low water mark at St. Louis, reached not quite 31 feet at Jefferson City. This proves that a very large percentage of the water of that season came from streams emptying lower down; either the Osage and Gasconade, or the Upper Mississippi and its tributaries.

In connection with this subject, I desire to recall attention to the idea, prevalent among the early settlers of this State, that the "June rise" in the Missouri is caused by the melted snow on the elevated plains and in the mountains about its source. This theory is now supposed to be exploded; and in the sense that the melted snow constitutes the water of the June floods, it doubtless is not true. But in the broader sense that the snow water *causes* these floods, I submit that this theory may be strictly correct. The large volume of cold water flowing into a lower latitude with higher temperature may so chill the atmosphere as, in connection with other meteorological conditions, to produce excessive rains, whose added waters make up the June floods. Observations upon the Missouri and the Lower Mississippi have satisfied me that this may be the true theory, and in fact it has long been a current one among the inhabitants of the low countries between here and the Gulf, where heavy rains are always expected in connection with the summer floods.

June 3, 1878.

The President in the chair. Thirteen members present.

In behalf of Mr. Geo. W. Lettermann, the Secretary presented to the Academy 20 different varieties of birds-eggs, collected from St. Louis Co.

Dr. Engelmann made a few remarks on the temperature of May.

The temperature of May last was more than 63°, which is 3 degrees below the average. Only three May months out of forty-two have been cooler, but frosts have occurred here, and no extreme temperatures. Vegetation has not been injuriously retarded, cool May weather having less effect in this regard than cool April weather.

Mr. Nipher presented a rain-chart of the State, and made a few remarks upon the May rainfall.

Jno. G. Kelley was elected to associate membership.

June 17, 1878.

A. Todd in the chair. Twenty-five members present.

The Corresponding Secretary announced the death of Joseph Henry, LL.D., Secretary of the Smithsonian Institution, at Washington, on the 13th of May, 1878, a Corresponding Member of this Academy since its first foundation in 1856.

Prof. Henry was born at Albany, N.Y., on the 17th December, 1797. His eminent services to science are too well known to need enumeration here, and will be better learned in detail from other sources. We may remember among ourselves the active and friendly interest he always took in promoting the objects of this society and aiding us in building up a museum and library, chiefly through exchanges of specimens and publications. We have been largely indebted, from the very beginning of the Academy, not merely to the agency of the institution over which he presided with so much learning and ability, but to his personal attention to our interests and prosperity, upon every suitable occasion.

The following resolution was unanimously adopted and ordered to be entered upon the minutes of proceedings:

Resolved, That the Academy of Science has learned with profound regret of the decease of Professor Joseph Henry, LL.D., late Secretary of the Smithsonian Institution, and that we take this occasion to record our high appreciation of his valuable discoveries and various contributions to scientific knowledge, his eminent character as a man, and his special services to this Academy.

Samuel D. Winter was elected to associate membership.

August 5, 1878.

This was a special meeting for the purpose of making arrangements for the meeting of the American Association for the Advancement of Science.

October 7, 1878.

G. Engelmann, President, in the chair. Seventeen members present.

Dr. Engelmann presented specimens of copper from the Lake Superior mines, making some remarks on the occurrence of copper in that region, and on the occurrence of copper ornaments and implements in Indian graves. Dr. Engelmann remarked that very few graves were found near the mines, or along the lakes, while they abound in the well known Wisconsin region.

Dr. Engelmann also gave some account of the vegetation along the lakes.

The country is partly flat, partly rolling, and is covered in many places with dense woods, mostly of coniferous or of deciduous soft wood trees. Among them the "Gray-oak of Canada" occurs, described by Michaux as *Quercus borealis* or *Q. ambigua*, our most northern oak, found from Lake Superior to Lower Canada and to Nova Scotia. Its acorns and leaves cannot be distinguished from those of our Red-oak, *Q. rubra* (Linn.), of which it is without doubt a northern variety with paler bark and tougher wood. It grows to be a large tree of over two feet in diameter, and its wood is highly esteemed in those regions.—I cannot make much of the figure of the acorn of *Q. ambigua* in Michaux's Sylva; it does not resemble any form of Gray-oak acorns I have seen. Can it belong to the following?

The other oak of the shores of Lake Superior is a kind of Black-oak, a smaller and, up there, much rarer tree, but which becomes much more common farther south, on dry land in Minnesota and Wisconsin, and seems to extend eastwardly to the New England States. Farther south it gives way to the ordinary Black-oak (*Q. tinctoria! Q. coccinea?*), which, though very variable in foliage, is always characterized by the large, thin, somewhat squarrose-tipped cup-scales: the Black-oak of the middle States. In Northern Illinois both are found. The northern Black-oak has a very rough, black bark; leaves coarsely or, often, very finely lobed (as to resemble the foliage of *Q. palustris*); a turbinate cup with small, appressed and more or less tumid scales, so that the cup appears tuberculated almost like that of a White-oak. The most common White-oak of Minnesota is *Q. macrocarpa*, popularly known under the name of Burr-oak.

A few plants otherwise peculiar to the Atlantic shores, also occur along the northern lakes, which is explained on the hypothesis that these shores were once sea-coasts.

Mr. Nipher presented a rain-map of Missouri, showing the distribution of rain during the summer months, as determined by the observers of the Missouri Weather Service.

October 21, 1878.

The President in the chair. Nine members present.

Mr. Nipher made some remarks on air vortices, produced by aid of a whirling table.

If a large unstoppered bottle be set in rapid rotation, the neck of the bottle will induce a sharp conical whirl, the vertex of which may be made to reach the bottom of the bottle. Its existence is revealed by a puff of tobacco smoke blown into the bottle after it has been rotating for a few minutes. If the whole bottle is filled with smoke, a dark vortex of clear air will be seen descending in the bottle.

Dr. Stevens gave an account of stone graves on the Meramec river near Fenton.

November 4, 1878.

Mr. A. Todd in the chair. Thirteen members present.

Dr. Chas. D. Stevens exhibited a human skull and tibia, with fragments of pottery, found in a stone grave on the Meramec river near Fenton. The skull possessed a remarkably low and receding forehead, and the tibia showed nodes which may have been caused by syphilis.

Mr. Geo. W. Letterman exhibited a stone implement, found near Allenton, the uses of which are unknown.

Dr. F. Kolbenheyer was elected to associate membership.

November 18, 1878.

Dr. I. Forbes in the chair. Twelve members present.

Mr. Silas Bent read a paper on the rotation of storms, which was referred to the Publication Committee.

Mrs. Abner Foster, of Beardstown, Ills., was elected to corresponding membership.

December 2, 1878.

Dr. Forbes in the chair. Eleven members present.

Mr. Nipher made a few remarks on the earthquake of November 18th.

Judge Holmes read the following note upon the

SANSCRIT AND NAHUATL.

In the "Anales del Museo Nacional de México" (t. i. 2, p. 79), Señor G. Mendoza institutes a comparison between numerous words of the Sanscrit and Nahuatl languages, and points out in them a striking identity of sound and sense, from which he infers some former connection between the two peoples. He suggests two different routes of migration by which such a connection may be explained: 1. By means of some tropical extension of the continent in the first stages of the Quaternary epoch, whereby a Sanscrit-speaking people may have reached Mexico; and 2. An eastward migration of the progenitors of the Toltecs, Olmecs, and Aztecs, from the banks of the Ganges and the Indus, across the Himalayas, and over the plateaus of Thibet, the deserts of Mongolia, and the frozen regions of Siberia, to Behring's Straits, and thence by Alaska to Mexico. And he refers to the Puratana Sastra, which relates, that, *some seven thousand years before*, a prince Yodah descended with his people from the Himalayas to attach Asgarta, the rich capital of India, and that, in consequence of religious wars following, there were large migrations of persecuted people to distant regions; and among them (he supposes) may have been the progenitors of the men who spoke the Nahuatl tongue in Mexico: and so the identities with the idiom of the Brahmans would be explained.

There are some serious objections to this theory. The Aryan-speaking peoples belonged originally to the white race, whose centre of origin is traced to the headwaters of the Oxus and Jaxartes in the basin of the Caspian Sea, north of the Himalayas. The Sanscrit-speaking Aryans of the Indus and Ganges were a branch of that same white race, and descendedfrom that original centre of origin, southward, into the valleys of those rivers at a date preceding the westward migrations of the Indo-Germanic peoples from the same original centre. This is the result of all philological and historical investigation hitherto. The Chevalier Bunsen places the date of this white Aryan race, in that common centre of origin, at a period at least 20,000 years ago. The Sanscrit form of the language received its developement in the valley of the Ganges and the Indus. The identities found in the Nahuatl might possibly show a derivation direct from the original form of the Aryan speech as it existed, primevally, in the earliest centre of origin rather than directly from the Sanscrit branch in India. This supposition would involve a migration only from the basin of the Caspian across Mongolia to Behring's

Straits: a migration from the Ganges over the Himalayas and the high plateaus of Thibet into Mongolia would seem to present insuperable difficulties. The supposition of casual wanderings of any individuals, or tribes, of the Sanscrit-speaking Aryans of the Ganges, through China to Behring's Straits, or by the driftings of boats across the Pacific from the coasts of Asia to Central America or Mexico, within the period of the Aryan occupation of the banks of that river, would seem to be equally impracticable; though such driftings from the coasts of Eastern Asia have undoubtedly taken place at different periods. The language, thus carried, would be Malayan, or Chinese, or Japanese, and not Aryan, though it would be still possible, perhaps, that some few words of Sanscrit origin might have been mixed with some language of the eastern coasts. This theory might explain the presence of some few Sanscrit words in the Nahuatl of Mexico, without reaching back at all to the first origin of the Mexican peoples, or to the first migration of the Nahuatl-speaking tribes into Mexico.

The traditions of the Aztecs to the effect that they came to Mexico from the north are too recent to throw any light on their actual origin; and they are sufficiently explained by the local migrations of the constantly wandering American tribes in times shortly preceding the Spanish conquest, and. if true, they do not require us to suppose a migration from any place farther north than the valley of the Gila river, where very ancient remains of human habitation have been found; besides, that the recent researches of Bancroft and others would rather indicate that the Nahualt-speaking Mexicans really came into Mexico from the direction of Central America.

Señor Mendoza places the time of the supposed migration of his Sanscrit-speaking progenitors of the Nahuatl people in the early stages of the Quaternary epoch. Before this epoch, the land connection between the two continents at Behring's Straits had been cut off by the sinking of the land; and the supposed route of migration, either from the banks of the Ganges, or from the basin of the Caspian Sea, for such Sanscrit-speaking progenitors, by this northern circuit, and through the regions of intense cold, and within any period that can be allowable for the antiquity of the Aryan speech at all, would seem to be inadmissible in the present state of our knowledge.

Then as to the other hypothesis of a tropical land connection of the continents, geological considerations preclude the supposition of such a land connection since the Miocene-Tertiary period, and certainly within any period than can be allowed for the antiquity of the Aryan language. But as late as the Pliocene period (as Mr. Wallace and Prof. Marsh have noticed) there was a land connection across Behring's Straits, when climates were warm even in that high latitude; and there was then, in all probability, a further extension eastward of the shores of the Asiatic continent, affording an easy passage along the coasts of Asia from the Malayan peninsula by continuous land in the direction of Japan and the Aleutian Islands to North America. And there can be little room for doubt, now, that this was the principal route by which the brown or reddish-brown race of Southern Asia, speaking non-Aryan languages, first reached the continent of America, and thus became the progenitors of all the American Indian populations. The existence of human remains in the Pliocene deposits of California is well established by geological evidences. But it is not possible to suppose that any form of the Aryan speech had then come into existence. Nor is it at all probable that any recognizable form of Aryan speech, and much less the Sanscrit, could have existed in the early stages of the Quaternary epoch.

It would seem to follow from these considerations, that any traces of identity between Sanscrit and Nahuatl words that may really exist must be due to infiltrations, at a comparatively recent date, through casual wanderers by sea or land, who may have become commingled with the aboriginal native tribes; but that for the origin of the American populations, in respect of both race and language, we must go back to a much older epoch.

Mr. W. T. Harris spoke at some length on the subject treated by Judge Holmes, remarking that no evidence of such a migration is found in any of the writings of the Asiatic nations.

December 15, 1878.

Dr. Forbes in the chair. Thirteen members present.

The Corresponding Secretary read a letter from J. S. Weston, of Rockwood, Ills., describing carved human footprints in a sandstone boulder near that place. The tracks are twelve inches in length, the great toe standing out at a considerable angle from the others. Judge Holmes remarked that, although such cases were not unusual, it would be of interest to secure full descriptions of the tracks.

Dr. Hugo Auler was elected to associate membership.

January 6, 1879.

Hon. A. Todd in the chair. Nine members present.

The Corresponding Secretary read the following letter from Professor Gustavus Seyffarth :

Nathaniel Holmes, A.M.,

Corresp. Secretary of the Academy of Science, of St. Louis, Mo.

Dear Sir:—My Chronology of the Ancient Eclipses, and approximate Corrections of the actual Theory of the Moon's Motions, published in the Transactions of our scientific Academy (vol. iii. pp. 401–530), being known, it will interest you that a distinguished astronomer of our country is just now occupied with constructing new Lunar Tables. Of course, since those of Hansen, presumed to be correct for all time to come, commenced after twenty years to disagree with the motions of the heavenly bodies, the replacing of them with better ones could not be deferred longer. It is Simon Newcomb, Prof. U.S. Navy, who, at present, aims to establish finally perfect Lunar Tables, as we learn from his "Researches on the Motion of the Moon, made at the U. S. Naval Observatory, Washington. Part I.—Reduction and Discussion of Observations of the Moon before 1750. Washington, 1878." In this very valuable work of 280 pages in quarto, the learned author first specifies the auxiliaries by which he hopes to solve the great problem. Concerning the latter, it is true, Prof. Newcomb recurs to a great many observations, formerly unknown or totally forgotten; but, on the other hand, he neglects the most important expedients, and relies on ancient eclipses totally wrong. Since the matter is of great influence; since I have discussed, though popularly, the same question in different works subsequent to my "Chronologia Sacra," and since my hand is responsible for neglecting to warn against the propagation of scientific falsehoods,—your love of science will certainly allow me to display the reasons which both prevent me from believing that Prof. Newcomb will, in the usual way, accomplish the end, and convince me that his new Tables will, after twenty years, turn out to contradict the observers as much as Damoiseau's Tables did in A.D. 1851, and those of Hansen in 1876.

In the first place, the manuscript observations preserved in the observatories of Paris, Luxemburg, Greenwich, Danzig, Petersburg, Pulkowa, etc., and the observations of the Arabians of Cairo and Bagdad, are, as it appears to me, too modern for fixing the places of the moon, her nodes and apsides, on account of the Roman, Greek, Babylonian and Chinese eclipses being 2,000, even 4,000, years older. Suppose those observations, made from A.D. 700 to 1750 without chronometers and telescopes, to contain defects of a few seconds concerning the times and magnitudes of the respective eclipses, what then?—Since these trifling errors increase rapidly backward according to the squares of times, it is evident that the aforesaid rather modern observations are not at all adapted to fix the secular mean motion of the moon, or her secular accelerations, since the epoch 3000 B.C.

Further, all astronomers maintain that the accelerations of the moon, her nodes and apsides, are periodical only, and that they are effected by the planets next to our globe, namely, by an unknown combined revolving period of them. This long period, first discovered in my "Chronologia Sacra," 1846, consists of 2146 Julian years, during which Saturn performed 74 revolutions, Jupiter 170, Mars 67 of 32 years each, Venus 268 of 8 years each, Mercury 168 of 13 years each, and the Moon 113 of 19 years each, the fractions being neglected. On a certain day of this period, the planets, inclusive of the Moon and the Sun, occupied the same sign of the Zodiac, and, 1072 years later, the same planets were united in the opposite sign. These combined attractive powers may perhaps have caused the acceleration and retardation of the moon, each lasting 1072 years. By the way, during 2146 years the fixed stars proceed nearly 30°, a whole sign of the Zodiac. This important combined planetary period is not mentioned by Prof. Newcomb.

Furthermore, the latter makes the older eclipses in Ptolemy's Almagest, as computed by Hartwich according to Hansen's Lunar Tables (Astronomische Nachricten, 1860, n. 1241), the groundwork of his new Tables, the *terminus à quo*. But Ptolemy's eclipses are linked to Ptolemy's Historical Canon, which does not contain one correct date prior to A.D. 80, as has been demonstrated *in extenso* in these Transactions, vol. iii. p. 401. All astronomers from Alphonsus's age to La Hire, Lalande, Burckhardt, and Damoiseau, based their Tables on the same eclipses (particularly since Petavius's *Doctrina Temporum*, Paris, 1627, was believed to have confirmed Ptolemy's Historical Canon), because nobody was able to restore the true history and chronology of the ancient nations, for want of mathematical certainties. At present things are changed. For since Ptolemy and Petavius, in whose days chronology was in its infancy, a great many chronological resources, as reliable as the Multiplication Table, have come to light, which put beyond question that Ptolemy's eclipses, apart from those observed by himself, belong to other years than the Alexandrian astronomer fancied. We specify once more a great many planetary configurations, referring historical events in controversy to certain years; conjunctions of planets; new and full moons observed on certain days, observations of the equinoxes and solstices on certain days and hours; a number of formerly unknown ancient eclipses, referred to certain days and hours: the Greek and Hebrew solar calendars; the inscriptions which compare certain days of solar months with those of lunar months; the four seasons of the Greeks, the true epochs of their Olympian, Pythian, Isthmian, and Nemean games; the Apis periods, and the like. By means of so many infallible arguments it has been brought to light that the whole Historical Canon of Ptolemy down to Titus is absolutely erroneous, and that the older eclipses in the Almagest have not been observed, but, by Ptolemy's computations, referred to wrong years. Now whoever, at pressent, intends to construct correct Lunar Tables by means of the eclipses in the Almagest, is morally bound before all to demonstrate both that the said eclipses belong really to the same years and days to which the Almagest refers them, and that my new chronology of the ancient eclipses is nonsense.

To this the astronomers like to object that Ptolemy's eclipses, if computed by the best Tables in existence, those of Hansen, agree pretty well with our Tables, and consequently, so they say, Ptolemy's eclipses must have been observed, as the Almagest reports. But this is fallacy, the so often mentioned *conclusio in circulo.* All Lunar Tables from the Alphonsian down to Lalande, Burckhardt, and Damoiseau, were constructed for the purpose of corresponding both with future eclipses and with those in the Almagest. Consequently, as often as we recalculate Ptolemy's eclipses by means of Lunar Tables based on the same eclipses, the Babylonian eclipses must of necessity agree with the Tables. This is the fatal self-delusion. Buerg was the only astronomer who, in spite of the Almagest, based his Tables on 3,200 Greenwich observations. According to the same Tables, three of the seven Babylonian eclipses were invisible ones, wherefore Buerg's Tables happened instantly to be banished from all observatories. And yet, on occasion of the total eclipse in 1851, it came to light that Buerg's Tables, not being based on Ptolemy's eclipses, were much more correct than those of Damoiseau, Burckhardt, or Lalande, of which the Almagest was the groundwork. This fact, together with Heiss's computations of the Greek eclipses visible during the Peloponnesian war, puts beyond question that the whole Historical Canon of Ptolemy is erratic, and that his eclipses must be referred to other years. Had Hansen's Tables not agreed with the Almagest they never would have been printed, or would have been soon after cast away like Buerg's. Had the latter taken the secular acceleration of the moon a few seconds greater than he did, his Tables would have remained practicable down to this day.

Besides, it is a gross delusion that Hansen's Tables harmonize with Ptolemy's Almagest. Hartwich's computations have evidenced (see these Transactions iii. 512) that one of these eclipses was invisible; another one, amounting to one-quarter of an inch, could not be seen with the naked eye; others were two, even three times larger or smaller; some of them happened 55m., 54m., 27m., 1h. 15m. later than the Almagest says. Suppose the Babylonian astronomers had observed these eclipses themselves to the nicety of minutes, then they must have been in possession of astrotronomical instruments for measuring minutes of time and parts of inches, But in this case, however, they could commit no blunders of 1hr. 15m., and never determine the minutes of eclipses being invisible. In short, it is Ptolemy who referred the eclipses in his Almagest to wrong years, and calculated their times and magnitudes.

To this the astronomers object that it would have been impossible for Ptolemy, by means of his very imperfect theory of the moon's motions, to compute eclipses being 800 years older. This impossibility, I confess, is not very plain to me. Ptolemy, having had the opportunity of astronomically observing four lunar eclipses in 125, 133, 134 and 136 A.C., could, by means of them, easily fix the longitudes both of the moon and her nodes for the epoch 100 A.C. Further, comparing these results with the 300 years older observations of Hipparch, notoriously the best astronomer of the ancients, he determined the longitudes of the moon and her nodes for the epoch — 800, and hence the secular mean motions of the moon and that of her nodes. The secular accelerations of the latter being unknown to Ptolemy, it was natural that he referred the Babylonian eclipses, linked only to certain years of certain kings, to wrong years, and that he discovered invisible eclipses and committed errors of one hour and fifteen minutes. Thus it is apparent how it came to pass that all Lunar Tables from Alphonsus down to Hansen were useless a few years after their construction, and that none of them corresponded with the classic eclipses.

My assertion that Ptolemy erroneously referred, e.g., the Babylonian eclipse of —717, Jan. 16th, 4h., to —720, Mar. 19th, 8h., is confirmed by the following fact. As soon as I learned that Hansen's new Lunar Tables were to agree with the eclipses in the Almagest, I communicated to him my researches concerning the true epochs of the eclipses in the Almagest. Some time after I myself went over to Gotha for the purpose of discussing with him orally the fallacy of the Almagest, but Hansen insisted upon it that his new Lunar Tables were the result of ten years of toil. As soon as Hansen's Tables were published I publicly prophesied, without being a prophet, that the work, after twenty or thirty years, would disappoint the astronomers as much as Damoiseau's Tables (inclusive of Airy's corrections) did in 1851. And lo! two years ago it came to light that the longitude of the moon was a good deal shorter than Hansen had presumed, and, consequently, that Ptolemy had antedated the Babylonian eclipses. I am sorry, indeed, that Prof. Newcomb relies on the Almagest.

Furthermore, the same lays great stress upon Zech's computations of some classic eclipses, of which the origin is as follows. Having since 1846 (Chronologia Sacra) and much more correctly in 1848 (Archiv. für Philol. p. 586) fixed the real dates of the classic eclipses, I convinced the Director of the Leipzig Observatory, the late Prof. Moebius, by my computations, that in all instances the longitudes of the moon and her nodes must have been shorter than the usual Lunar Tables state. My harmonious corrections of the latter surprised Prof. Moebius so much that he resolved to decide the question by the help of the Tablonowskian Society at Leipzig, and by two prize theses. The first of these, published in 1851, concerned the eclipses in the Almagest, which were computed by the instrumentality of Damoiseau's Tables, based on the Almagest. The result, of course, was that Zech's computations agreed with the Almagest in consequence of a *demonstratio in circulo*. In the same year, the same Society elicited the second prize thesis, viz., to decide whether some classic eclipses correspond with Airy's corrections of Damoiseau's Tables or not. Having demonstrated myself, three years earlier, that Petavius had all events and all eclipses of the Greeks and Romans referred to wrong years, I expected indeed that the aforesaid Society would select a number of eclipses, really observed by the Greeks and Romans, to be taken into account. But the late Prof. D'Arrest, then Adjunct at the Leipzig Observatory, being a very young man, made only a small number of classic eclipses, viz., the same which Petavius had computed by means of La Hire's Tables, relying on the Almagest, the object of the prize thesis. Since, then, both La Hire's and Damoiseau's Tables agreed with the eclipses in the Almagest, the result, of course, was again a vicious *conclusio in circulo.*

As soon as Zech's Prize Theses were issued, I came out with my remonstrances in "Göttingen Gelehrte Anzeiger," 1855, n. 125. (See my "Berichtigungen der Geschichte," 1855, p. 99) In order to construct correct Lunar Tables, the question is not, how far Hansen's or similar Tables harmonize with Ptolemy's and Petavius's eclipses; but the principal and previous duty is, to make out, by the help of the present historical and astronomical resources, *in what years the Greek, Roman and Babylonian eclipses really have taken place.* Had the Tablonowskian Society longed, before all, for a pamphlet deciding, according to the present chronological auxiliaries, to what years all the classic and Babylonian eclipses are to be referred, that learned corporation would have rendered an immortal service to science. I am very sorry that Prof. Newcomb laid any stress upon Zech's computations, restoring the old historic chaos of Ptolemy and Petavius.

Again, it is presumed that Airy's and Hind's computations of some classic eclipses confirm the present theory of the moon's motions, and, apart from trifles, Hansen's Tables corresponding with the Almagest. This argument is astonishing indeed. For, according to the computed eclipse in —584, Cyrus was wonderfully born prior to his mother. (See these Transactions iii. 516.) In case the eclipse of Xerxes was that in — 474, Feb. 16, 23h., the sun rose on that day very late, viz. after noon in Smyrna (id. p. 518). If the eclipse of Larissa happened in — 556, then the Babylonian captivity "of 70 full years" would have lasted 45 years only. In case the eclipse of Agathocles was that in —309, Aug. 15, then the Greeks called the summer winter, and the winter summer. Surely this is treating the sound common sense of mankind with contempt! — I do not understand how learned men, who obtained a classic education, and know what logic and common sense are, could expect to succeed in constructing ancient history *à priori.* Clio is a sacred virgin, descended from heavenly parents, and it is a shameful act to abuse her for supporting fallacious theories. Whoever holds Hansen's Tables and the present theory of the moon's motions to be true, is under necessity to adopt the aforesaid absurdities, and to believe that the Greeks celebrated the Olympian games sometimes after four, sometimes after three years; that the Peloponnesian war lasted not 28 years, as the eye-witnesses Thucydides and Xenophon testify, but 27 years only; that the total eclipses of Xerxes and Plutarch were fabrications; that the Annales Maximi and Livy omitted a whole year of Roman history; that Cæsar was not seven times, but six only, Dictator; that the eclipse perceived at Rome and at Teos in Asia Minor soon after the founding of Rome, was an imposition, and so forth.

In one word, it is absolutely impracticable to bring the 19 eclipses in the Almagest into harmony with the 100 Greek and Roman eclipses; either the former or the latter must be given up. *Tertium non datur.* It can by no means be demonstrated that Ptolemy's older eclipses were observed, as the Almagest says, by Babylonian astronomers; and they contradict, apparently, Greek and Roman history. The classic eclipses, on the contrary, are chronologically fixed by mathematical certainties, and the classic authors were, in nearly all instances, eye-witnesses; they were able and willing to tell the truth; they had nothing to gain or to lose by imposing on their contemporary or future readers.

The principal differences of the theory of the moon, derived from the Almagest, and that based on the classic eclipses, will be seen in the following table:

	☽ Long. m.	Anom. m.	☊
I.	$1^s\ 18^\circ\ 42'\ 21''$	$10^s\ 20^\circ\ 47'\ 28''$	$9^s\ 11^\circ\ 30'\ 20''$
II.	1 16 3 54	10 17 4 13	9 4 0 46

No. I. is, in the first place, the mean longitude of the moon, apart from the secular equation, for the epoch —800, Jan. 0.0., determined by Lalande and by his predecessors and followers, trifling deviations not being noted. The following figures represent the mean longitude of the apsides, and, after them, that of the moon's node for the same epoch, according to Lalande, etc. It is true, by applying these principal elements of the theory of the moon's motions, the eclipses in the Almagest come out *taliter qualiter;* but the whole Roman, Greek, and Egyptian histories concur in proving that Ptolemy referred all his older eclipses to wrong years, and, moreover, it is absolutely impossible to harmonize this theory with the classic eclipses, of which the times and magnitudes are reported. (See Trans. iii. 525, l. 9.) In order to represent Ptolemy's eclipse in —720, March 19th, 6h. 49m., the longitude of the moon was presumed to have been $11^s\ 19^\circ\ 52'$; but in this case the eclipse during the founding of Rome, as well as that near Smyrna in —478, Feb. 17, 15h., and the like, would have been illnsions. For the purpose of obtaining a total eclipse in —380, Dec. 12, 9h., it was necessary to place the ☋ $2^\circ\ 31'$ east of the sun, but in this case it turned out that none of the "total" Greek and Roman eclipses were total. The following two facts will suffice to convince every unprejudiced man. Aristophanes, a reliable eye-witness, testified in the face of all the Athenians, being present whilst his "Nubes" were enacted, that in the preceding spring of the year in which Cleon was lawfully elected strategus, both a total eclipse of the moon and a partial one of the sun took place within fifteen days. The scholiast specifies even the day of the latter, namely, the 16th day of Anthesterion, i.e. Jan. 18th, —420 (l. 14, p. 475). Such an eclipse only once coinciding with Jan. 18th during a period of 19 years, the date of this eclipse is fixed with mathematical certainty. But, alas, on the said day, confirmed by the total eclipse of the moon during the spring of the same year, viz. that is, —420, Feb. 2d, no eclipse of the sun was possible on our globe. For on the said day the ☋ lay 17° east of the sun, and in this case, as every astronomer knows, the eclipse was visible only beyond the north pole; and this is ratified by Pingré's computations of all eclipses visible on our globe. In order to obtain, on the aforesaid day, a partial eclipse in Athens, the longitude of the ☊ must have been shorter by about 5° than our Tables state. In this case, however, the eclipses in the Almagest do not come out. Now, I ask, is this eclipse not much more reliable than those in the Almagest not observed by Ptolemy? Further, Livy and the Annales Maximi bear witness that in —216, February 11th, 2h. 30m., a very small eclipse (*solis orbem minui visum*) was seen in Sardinia, which amounted, according to the Ptolemean theory of the moon, to 8 inches, because the ☊ lay 5° east of the sun, and the curve of the moon's shadow was 0°, 8°, 45°. This contradicts the Annales; the longitude of the ☊ must have been shorter by about 4°. Besides, Silius Italicus (viii. 634) reports that the same eclipse was total, or nearly total, in Calabria. Now, the longitude of the ☊ being shorter by about 4°, this eclipse was really small in Sardinia, but nearly total in Calabria. The passage of Silius Italicus is wanting in my treatise; I found it first in Newcomb's work. Once more, these two facts incontrovertibly demonstrate that Ptolemy's lunar theory is wrong.

It will be objected, however, that the accelerations of the moon's motions, proposed p. 429, is too great to be effected by the disturbing forces of the planets, and, in general, that they conflict with the law of gravitation. To this I reply, that my figures are but approximate ones, and that it is the problem of professed astronomers to harmonize the different lunar motions with each other. I claim only to have incontrovertibly fixed the chronology of the ancient eclipses.

At present, the only way for establishing correct Lunar Tables is, as it seems to me, to compute fifty or more authenticated classic eclipses, and to compare them with each other and with modern observations, in order to fix before all the principal elements of Lunar Tables; the secular mean motions of the moon, her nodes and apsides, and their secular accelerations.

Since Prof. Newcomb, p. 279 of his work, says, "the only course will be to make a complete re-examination of all ancient eclipses," I hope that he will take this very course. But should he, however, make the Almagest the basis of his new Tables, you will allow me to predict once more that his new Tables will, after twenty years, be as useless as Damoiseau's and Hansen's were in 1851 and 1876. The loss of several years in the life of a distinguished astronomer like Newcomb would be a great loss for science.

I myself, being 82 years old, shall not outlive the triumph of the truth; but you, I presume, will see with your own eyes the accomplishment of this prophecy.

Respectfully yours,

Prof. Gus. Seyffarth.

New York City, Dec. 20, 1878.

Dr. G. Engelmann, the retiring President, made the following

ANNUAL ADDRESS.

GENTLEMEN: — The history of our Academy for the past year is very nearly a repetition of that of the preceding ones. Our home is, on sufferance, in this hall, by the courtesy of the Board of Public Schools. Our library is stowed away in some corner of this building, and our poor collections are preserved in a few cases up-stairs.

The meetings have been regularly attended and a number of interesting papers have been read, and interesting discussions on various subjects within the scope of our pursuits have been had. A new number of our Transactions was published in the beginning of the year, completing our third volume, and the first number of the fourth volume has been commenced. Our Archæological Section has already amassed an important collection, and is actively engaged in the preparation of a valuable publication, a number of plates for which are already finished, and will, with the aid of the Academy, it is expected, soon see the light.

A number of volumes have been added to our library by the liberality of the numerous foreign and domestic institutions with which we exchange, as the Corresponding Secretary's report will exhibit.

The Treasurer will give you an account of our financial condition, showing that we are, if not rich, at least free from debt, and that a surplus of over $200 has been paid over to us from the contributions for the entertainment of the American Association in August last.

And such will be the modest history of our Academy for the next years, unless we take a new departure and by united efforts—efforts of our members as well as of our citizens—raise our institution to the position which the Academy of Science of the third city in the United States ought to and will occupy. The present moment is particularly adapted for such a fresh start.

The American Association for the Advancement of Science, which honored and gratified us last August with its presence, has brought the matter more immediately and forcibly home to us, and has produced among our citizens a higher appreciation of science, and has created and stimulated among us a spirit which, it is hoped, will help us to build up an institution worthy of our great city and State.

Another most favorable circumstance comes to the aid of this newly-awakened spirit. The building of the female branch of the Washington University, known as the Mary Institute, on Lucas place near Fourteenth street, has been vacated for other more extensive quarters, and, as the authorities of the University permit me to state, can be procured for our Academy for the sum of $25,000. The building is situated in a very desirable part of the city, and in a neighborhood in which considerable influence may be expected to develope in order to have such an institution as ours among them, and not the possible alternative of a hospital or a public school, the only purposes for which otherwise the large building may be adapted. For our uses few alterations would be necessary.

It is true that we are already part owners of a lot donated to us and to the Historical Society, jointly, by the late Mr. Lucas. But that lot has, through circumstances, which I need not detail now, been rather an impediment than an advantage to us, and has actually crippled our progress. My advice, therefore, is to dispose of our share in this lot, or, if that cannot be done, to abandon it, and try to establish ourselves in the "Mary Institute."

It is believed to be not only probable, but quite feasible, to raise the $25,000 among our citizens for the acquirement of the building in question, and I am permitted to inform you that one-fifth of that sum ($5,000) has already been secured, with the understanding that the other four-fifths be raised; for the whole amount ought to be raised and paid, so as to acquire the fee simple, free of any incumbrance or debt.

Let me tell you, however, that the acquisition of the building — of a home for us — will not be sufficient in itself; though the most important beginning, it is only a beginning. A home must be furnished and the expenses of living in that home must be provided for, and they cannot be obtained from our annual contributions, which will be altogether absorbed by our publications, which are so essential in keeping up our intercourse with the world of science.

It is believed that an endowment of at least $25,000 more will be necessary to carry on our institution, keep our library and museum in proper condition, and pay for the running expenses of curator, janitor, light, and fuel. It should be our object to obtain such an endowment.

Will our citizens raise these $50,000 and place us in a position to invite another meeting of the American Association for the Advancement of Science to an academy and museum worthy of the great city of St. Louis, and not oblige us to hide our heads when asked, Where is your museum? where the centre of natural science in the West?

The Corresponding Secretary submitted his annual report.

To the President of the Academy of Science:

I have to report that, during the year 1878, the operations of the Corresponding Secretary have been conducted in like manner as heretofore. Our correspondence and exchanges have somewhat increased. In February last, No. 4 of vol. iii. of the Transactions was issued and distributed to our exchange lists and to members and subscribers entitled to receive it, the remainder of the edition being deposited in the Library. During the year, 407 copies of all numbers, but chiefly of No. 4, vol. iii., came to my hands for transmission or sale, of which 393 copies were sent to supply the exchange lists, and 4 copies were sent to subscribers; and 8 numbers have been sold for cash; leaving 2 copies in my hands.

Our foreign exchanges have been effected, in the usual manner, through the Smithsonian Institution; though we receive many publications by mail also.

Besides the regular course of exchange of annual publications from all correspondents, which are numerous and important, we have received this year the valuable Transactions of the Royal Irish Academy of Dublin, comprising vols. xxiv. to xxvii., Pt. 1, and the Proceedings, vols. i., 2d series, to iii., No. 1, 1877; and from the Royal Academy of Sciences of Lisbon its Memoirs, vols. iv. and v., together with the "Portugaliæ Monumenta Historica," the "Historia da India," the "Historia dos Estabelecimentos de Portugal," and other publications of much value, in several 4to and 8vo volumes. We have continued to receive the many large and valuable scientific volumes and Atlases published under the directions of the Department of the Interior at Washington, and of the office of Chief of Engineers, U. S. A. Among these, the Geology of the 40th Parallel, by Clarence King, U. S. Geologist, with a splendid Atlas of Maps, and the Reports of the U. S. Geological and Geographical Survey of the Western Territories, by Dr. F. V. Hayden, U. S. Geologist, are worthy of special mention.

During the year, seven additional Societies have been added to our Foreign Exchange list, and four to the Home list. The Foreign list now comprises 235 names, and the Home list 107 names. The exchanges we are annually receiving from all correspondents are making a constant and important addition to our Library, which, at the present time, contains doubtless the largest collection of scientific publications to be found in the Mississippi Valley. It is safely kept and sufficiently accessible, though not so conveniently as might be desirable; and in all the future it must constitute a body of scientific literature which will be of great importance to all who are engaged in scientific researches among us, and for general reference.

We are under great obligations to the Board of St. Louis Public Schools for the safe accommodation which they furnish for our library, cabinets, and place of meeting in the Polytechnic Building, free of any considerable expense to the Academy. Whenever the Academy shall become permanently established in a suitable building of its own, erected and arranged for its special purposes, the operations of the institution will be still more effectually carried on, and its usefulness may be greatly increased.

The list of Corresponding Members, at the present time, comprises about 132 names of members who are still living so far as yet known. Two names have been added to the list during the past year.

The prospect now is, that the Committee on Publication may soon begin the printing for another number of the Transactions, which may be issued in a few months.

I submit herewith my account of the receipts and expenditures of this office for the year 1878,

showing receipts to the amount of..................................	$38 62
and expenditures..	33 43
leaving a balance on hand of	$ 5 19

Respectfully submitted,

Jan. 6th, 1879. NATHANIEL HOLMES,
Corresponding Secretary.

Election of officers then took place with result as follows:

President—George Engelmann.
First Vice President—Albert Todd.
Second Vice President—Wm. H. Pulsifer.
Corresponding Secretary—Nathaniel Holmes.
Treasurer—Enno Sander.
Recording Secretary—Francis E. Nipher.
Librarian—Frederick M. Crunden.
Curators—G. Hambach, Geo. J. Engelmann, W. B. Potter.

Mr. John Shepherd, of Macon, Mo., was elected to corresponding membership.

January 20, 1879.

Mr. A. Todd in the chair. Ten members present.

This meeting was devoted wholly to business, and a committee, consisting of W. H. Pulsifer, Charles Speck, Chas. A. Todd, F. F. Hilder, and F. E. Nipher, were instructed to take into consideration the suggestions contained in the President's annual address of Jan. 6, 1879.

February 3, 1879.

Vice President A. Todd in the chair. Eight members present.

Mr. Nipher made the following communication on the earthquake of November 18th, 1878:

The shock of this earthquake was felt over an area of fully 150,000 square miles. The region disturbed forms an ellipsis, the major axis of which extends from Leavenworth, Kas., to Tuscaloosa, Ala., a distance of over 600 miles. The minor axis extends from near Clarksville, Ark., to a point midway between Cairo, Ills., and St. Louis, a distance of 300 miles. The southern boundary of this region has not been determined with as great accuracy as is desired. The region of greatest disturbance was along the Mississippi from Cairo to Memphis. Here the shocks were universally felt. The walls of buildings could be seen to move, and strong frame buildings creaked as when every joint is strained by a heavy wind. At Ironton the shock was also so severe as to alarm some who lived in brick houses. Along the Missouri, from Glasgow to Lexington, the shock was also severe, awakening many families, who thought a heavy wind-storm was in progress.

It appears that the shock was first felt at Glasgow 11h. 23m. P.M. (St. Louis time). The shock travelled rapidly down the axis of the ellipsis, reaching Cairo at 11h. 48m., and Memphis at 11h. 50m. The velocity of transmission is a matter yet under consideration, and will receive attention in a future bulletin.

At Little Rock, Ark., the shock was also distinctly felt, although not observed at Clarksville, 35 miles farther up the river.

Earthquakes are to be expected over this region, and it is hoped that all interested in scientific work will hold themselves ready to make accurate observations on them.

Dr. G. Hambach exhibited specimens of shaly limerock, containing well-preserved remains of different species of insects, of which he had over 400 specimens, obtained from the pliocene or upper tertiary of the Rocky Mountains. The specimens were found some 40 miles from Colorado Springs.

Mr. Alexander Leonhardt was elected to associate membership.

February 17, 1879.

A. Todd, Vice President, in the chair. Thirteen members present.

Mr. Holmes called attention to a memoir, by Oswald Heer, upon the fossil botany of northeastern Asia. The evidence adduced tended to prove the existence of a land connection across Behring's Straits as late as the Pliocene period.

Mr. Alexander Leonhardt read a paper on the microscopic examination of rocks. Many interesting rock-sections were submitted for examination.

Dr. Charles Ludwig was elected to associate membership.

March 3, 1879.

A. Todd, Vice President, in the chair. Ten members present.

Mr. Nipher made some experiments on vibrating plates.

Edward Walsh, Jr., was elected to associate membership.

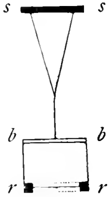
March 17, 1879.

Chas. Speck in the chair. Ten members present.

Mr. Chas. M. Scott read a paper on "Plans of Improvement of Western Rivers." This paper was referred to the Publication Committee.

Mr. Nipher described a new device for the projection of pendulum figures while forming.

The bob of the pendulum consists of an iron ring (*rr*) about 20 inches in diameter, and weighing 25 or 30 lbs. From opposite extremities of a diameter, metal rods (*r b*) pass upwards to a cross-bar (*bb*), from the middle of which the pendulum is suspended on a single wire, or chain. In order to obtain vibrations of various kinds, this single wire may be made to branch into two wires at any desired point, in the usual manner. Passing through the iron ring at opposite points are two long screws, the inner ends of which are connected by a small wire, swivels being introduced in such a way that the wire can be stretched without twisting. The middle point of the wire bears a stylus, the lower extremity of which rests upon a blackened glass. This glass, which is directly over the condensing lens of a vertical lantern, is carried upon a ring provided with a vertical rack and pinion movement, so that the tracing can be stopped at any moment by lowering the slide. The bar (*bb*) should of course be far enough above the ring to accommodate the focusing lens and the mirror which reflects the beam of light to a vertical screen. With a pendulum 15 ft. in length, the effect on the screen becomes very striking and impressive.



April 7, 1879.

A. Todd, Vice President, in the chair. Eight members present.

In behalf of Chas. M. Scott, the Corresponding Secretary presented a detailed map of the Mississippi River.

Mr. Nipher stated that during the last month the thunderstorms in Missouri had been most frequent along the rivers Mississippi and Missouri, and upon the high region running from St. Louis to the southwestern part of the State. This distribution was quite marked. These storms were all feeble and local, and it was observed that local peculiarities of surface might well have a more marked effect under such circumstances.

April 21, 1879.

Dr. Engelmann, Pres't, in the chair. Nine members present.

The sculptor Macdonald presented a plaster model of the "Serpent mound" of Adams Co., Ohio. This mound is described in the work of Squier and Davis. Mr. Macdonald was commissioned by Squier to execute a model for exhibition at the Centennial Exposition, and had retained a copy for himself, which was donated to the Academy.

On motion of Mr. Todd, the thanks of the Academy were voted to Mr. Macdonald.

Mr. Nipher exhibited specimens of vulcanized fibre.

Dr. Engelmann stated that in regard to the popular idea that tornadoes were more common of late years than formerly, the most that can be said is that they are more generally observed now than when the country was more sparsely settled, and such observations receive at once a wider publicity than in former days. He had seen tornado tracks in great numbers in the woods of south Missouri and Arkansas forty-five years ago.

Mr. Nipher introduced the following resolution, which was passed:

Whereas it is in harmony with the objects for the promotion of which this Academy was founded, to encourage enterprises which will increase our knowledge of the physics of the globe; therefore,

Resolved, That this Academy warmly commends Capt. Howgate's plan of Polar colonization, and urges upon Congress to pass the bill making provision for the expenses of the project.

May 5, 1879.

Dr. Engelmann in the chair. Ten members present.

Mr. Nipher read a paper on the tornado at Collinsville, April 14th. The paper was referred to the Publication Committee.

Dr. Engelmann remarked on the continued dry weather since April 14th, that, according to the Missouri Weather Service, it covered the eastern half of the State. The frost of the early part of April did more damage than was done by the April frost of four years ago, as vegetation is further advanced. At present, by reason of the warm weather of the latter part of the month, the general blooming of fruit is not backward, although imperfect and irregular.

The President introduced Mr. O. Pavy, who made some remarks on Arctic exploration. His well known views in regard to the Behring's Strait route were defended, and many facts tending to prove the existence of an open polar sea were cited.

May 19, 1879.

The President in the chair. Eleven members present.

Dr. Engelmann presented plates to illustrate a pine partially described by him several years ago as *P. Elliottii*, and read by title a paper in further description.

Mr. Nipher read a paper on "Magnetic Determinations in Missouri during the Summer of 1878," and exhibited the apparatus used in the survey. These papers were referred to the Publication Committee.

June 2, 1879.

A. Todd, Vice President, in the chair. Eleven members present.

In behalf of Mrs. Pickering, wife of the late Charles Pickering, the Corresponding Secretary presented a copy of Pickering's "Chronological History of Plants." The thanks of the Academy were voted for this valuable work.

Mr. Collet made a few remarks on the occurrence of native Epsom salts in the magnesian limestone bluffs near Jefferson City. The quantity was said to be considerable.

June 16, 1879.

Dr. Engelmann in the chair. Ten members present.

Mr. Letterman donated the nest of a humming-bird, which he had found on a white-oak. Dr. Engelmann remarked that these nests were always found on oak trees.

Dr. Stevens presented a collection of clay concretions, found in a clay bank near Jerseyville, Ills.

Dr. Engelmann showed some unripe grapes already affected by rot. He stated that the removal of this fungus growth, when once established in a vineyard, was very difficult. He thought that sulphur or crude carbolic acid mixed with quicklime, and used as a manure, would be of great service.

Dr. Engelmann also stated that the past May was the driest

May he had observed in forty-five years, and that thus far every month of the year has given us less rain than the average.

October 6, 1879.

A. Todd in the chair. Ten members present.

The Corresponding Secretary presented in behalf of Mrs. Abner Foster, of Beardstown, Ills., a box of mound builders' crania, with a collection of flints; accompanying which was a paper entitled, "A Description of Mounds and Prehistoric Relics of Cass, Schuyler and Brown Counties, Illinois."

On motion of Judge Holmes, this paper was referred to the Publication Committee.

He also presented a photograph of footprints on the triassic rocks near Booneville, N. J., a donation of Mr. Israel C. Russel.

In behalf of James H. Brookmire, Dr. Forbes presented four specimens of spider-crabs, from Biddeford Pool, Maine.

October 20, 1879.

Dr. Engelmann in the chair. Nine members present.

The Corresponding Secretary read the following communication from Capt. Chas. M. Scott on

THE FORMATION OF THE BANKS OF THE LOWER MISSISSIPPI.

The banks of the Mississippi below the junction of the Ohio present phenomena that have often led to erroneous opinions. The banks are sometimes at different heights at places in close proximity to each other. At one place, the river overflows the banks, during high water, from one to three feet, and again, in less than a mile, banks are found that extend above the highest water known, from one to three feet, and occasionally even more. These high banks have been taken as a proof of an earlier formation.

I do not claim to be a scientist in any way; yet, having been an observer of the phenomena of the Mississippi, I will presume to give you the observations I have made in the hope that facts will lead to a better understanding of the laws that govern our river. The first thing that strikes an observer is the instability of the banks. The second is the luxuriant vegetation; and if the observer passes during low water he will not fail to notice the size and frequency of the sandbars. The banks are composed of alluvium with a large proportion of sand. This mixture is not of uniform texture, but has a greater proportion of sand as the deposit that forms the present banks has taken place on the outer side or on top of a bar, or under or behind a bar, or haply in an old cut-off. Should it be on the outside or on top of a bar, the banks will be found to be very sandy, having no coherence, and mouldering away at the slightest touch; but if the deposit has taken place behind or on the lower side of a bar, the bank has a greater tenacity and resists abrasion until undermined by the current, and falling over is broken up and swept away. If the deposit has been formed in an old cut-off, it becomes, above the mouth of the Arkansas and on the east side all the way down, stiff tenacious blue-black clay; but on the west side, after passing the mouth of the Arkansas, we frequently find it mixed with the red deposits of that river. At several places below the Arkansas there is a stiff clay formation, particularly at Cypress Bend, 25 miles below the mouth of the Arkansas, and in Yellow Bend, 10 miles below that, on the same (west) side; but this clay bank has frequently branches and logs imbedded in it. This blue clay, as well as the yellow, makes a more permanent bank than the more sandy, and better resists the action of the current. The sandbars are mostly formed under points where the current is slack, and are composed of the sediment brought by the current from above and deposited in the slack current.

Occasionally, a sandbar is formed in the middle where the river is wide, and if the conditions are favorable the sandbar becomes a towhead — a sandbar with young cottonwoods or willows — and eventually an island. The sandbar formed under the point is increased every high water by the silt, and either willow or cottonwood takes root and covers the higher parts with a dense carpet of verdure. After vegetation has begun, the building of the bar goes on with increased rapidity; for in addition to the increased deposit of silt during high water, there is added, when the river recedes in the summer, the action of the wind. When the wind comes from a favorable direction, it lifts the sand from the more exposed parts of the bar, and deposits it among the young growth on the higher parts; and again, when the wind comes from an opposite direction, it brings the leaves gathered from the forests behind, which add to the mass, and thus, alternately, the wind deposits either sand or leaves, and the annual high water, adding its silt, solidifies the mass until it reaches high water, and then the wind continues the process.

Again, another element comes in to increase the effect: this is the cut-off. These cut-offs are caused by the current cutting across a narrow neck of land, causing the current and channel to leave its former bed and take a new direction, frequently shortening the river ten or fifteen, and in some cases as much as thirty miles. The effect of these cut-offs is to lower the bed of the river, immediately above, about three inches (depending on the slope of the river) to the mile. This lowering is gradually lessened as we recede from the cut-off up stream. The effect below the cut-off is the reverse of what it is above. If the cut-off takes place close under a point where the wind has been raising the bar to or above high water, we shall find a bank from two to four feet above high water level. These cut-offs are becoming more frequent as the banks become denuded of timber.

The following places illustrate the effect of wind alone in raising the banks above high water. The left bank from the foot of Island 21 to Hale's Point, and Rucker's Point immediately below. Previously to 1828 the channel came down, as it does now, to the right of 21, following the bend to about Mrs. Hickman's; thence crossing past the foot of the island into what is now known as Obine lake, and, following it ten miles, came back into the present channel at Wales' Point, crossing what was then known as the Canadian Reach.

In 1828 the river cut through the narrow neck, leaving the former bed as a lake, and, as it gradually cut the right-hand point away, it formed a bar across the head of the lake: the lower side was kept open by the Obine river finding its way through into the main river. After the bar formed across the head and the vegetation took root, the action of the wind raised the bank in the old channel above high-water mark. The same effect is shown at Rucker's Point five miles below, where the highest land is found in what was formerly the middle of the river. There are many other places that might be named that show the same effect, such as Congo's Point behind Big Black towhead, opposite Hardtimes landing, and the point above Rodney. All these places are out of the influence of cut-offs except Congo's Point; and there the Davis' cut-off (of twenty-five miles) being immediately above, as a consequence, raises the water below; still the point is above overflow.

The combined effect of the wind and cut-off is very conspicuous at Dean's Island (above Devil's Elbow cut-off, 40 miles above Memphis), at Walnut Point, at Brunswick Point (above Terrapin-neck cut-off, 30 miles above Vicksburg), and at Ruth's Point (opposite the mouth of Red river).

Red-river Reach shows the effect of cut-offs alone, having Red-river cut-off of 12 miles (occurring in 1830) and Raccoussée cut-off of 25 miles (occurring in 1848); the two combined have raised the banks from a low swamp to from two to three feet above high water.

Dr. Engelmann made the following remarks on the recent hot weather:

After a rather cool September, 4° below the average, on Saturday, the 27th of that month, this hot spell of weather set in, and continued to the 16th of October—20 days. In those 20 days the temperature did not fall below 60° at night, and the daily minimum was sometimes as high as 70° and 71°. The daily maximum was almost always over 80°, and once or twice rose above 90°. Only twice in those 20 days was the daily maximum as low as 75°. The averuge temperature of the 20 days was 73°, which is 18° higher than the average for October.

It is not probable that the next ten days will lower the temperature to anything like the average temperature of October, which is 55°.7.

Prior to the present year, eleven October months in 45 years haves hown a temperature above 58°, and three have been above 60°. In 1854 the October temperature was 61°.4, in 1852 it was 62°.3, and in 1839 it was 62°.8.

In the three warmest Octobers mentioned we had no excessively high temperature; in fact, no three days in succession with a temperature of over 80°; but the weather was uniformly mild, and thus a high mean was attained — another of the numerous instances which show that mean temperatures alone by no means allow a fair estimate of a climate.

Of the eleven years mentioned above as having unusually warm Octobers, four were followed by a winter below the average temperature of 33°.4, and one of them, 1871–2, was one of the coldest. Three winters after, an unusually warm October had nearly an average temperature, and four were warmer than usual, that of 1877–8 being an unusually mild one. It is therefore evident, that conclusions on the temperature of the following winter cannot be drawn from the temperature of the month of October.

November 3, 1879.

Dr. Engelmann in the chair. Eleven members present.

Dr. Engelmann made a few remarks on the meteorology of the past month.

Mr. Nipher made a short communication on the contamination of brass by steel tools.

November 17, 1879

Charles Speck in the chair. Seven members present.

The Corresponding Secretary read a paper from Dr. G. Seyffarth, of New York, on "Planetary Configurations on Cyprian Antiquities," which was referred to the Publication Committee.

December 1, 1879.

Dr. Engelmann in the chair. Nine members present.

Dr. Engelmann made a few remarks on the unusual turbidity of the river water. He stated that the amount of suspended matter was unusually large for this season of the year, that it deposited very slowly, and that its color was much darker than the usual sediment of the Missouri. The color was only slightly changed at a red heat.*

Dr. Engelmann also made the following communication on

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* Prof. Potter subsequently suggested that this sediment must have come from northwestern Missouri and eastern Kansas, and it was shown by the reports of the Missouri Weather Service, that rains in this region had been of an unusually heavy and washing character, three inches having fallen in one day over this region just prior to the rise.

F. E. N.

WILD GRAPES.

One of our most important grapes, *V. labrusca*, or the Northern Fox Grape, does not cross the Alleghanies, being a native of the eastern slope. This grape has been improved by cultivation and has given rise to all our larger-berried varieties, as Isabella, Catawba, Concord, etc.

V. æstivalis, or Summer Grape, is abundant throughout a great part of the United States, but does not grow wild west of the woods of the Mississippi Valley. This grape is the base of the Virginia Seedling, the Herbemont, and other cultivated varieties.

V. riparia of Michaux, also known in this neighborhood as the June grape, and the River-bank grape, grows farther north than any of the others, being found at Lake Superior, and, skipping the plains, is found on the eastern slope of the Rocky Mountains. It also grows in Texas. But in the east it does not seem to occur south of Pennsylvania. It is an early grape, and sweet and very palatable.

V. cordifolia, or winter grape, does not grow north of New York and Central Illinois, but at Washington and Philadelphia it is the most common grape. The trunk of this grape is the largest of all, being sometimes from eight to twelve inches in diameter, at least in the river bottoms of the Mississippi Valley, and climbing the highest trees; its fruit is rather disagreeable.

The French are now obtaining from the woods in this vicinity a large number of cuttings and an immense quantity of seed, principally of *V. riparia*, but also of other species, having discarded the Labrusca entirely. As the Labrusca does not grow wild in this region, there is no danger of getting here hybrid varieties. Our wild grapes are used in France as stocks to graft their own vines on, in the expectation that the American stock will resist the destruction of the Phylloxera, which has made such sad havoc among their grapevines. It has already destroyed one entire fourth of the French vineyards, thereby crippling materially the prosperity of the country.

December 15, 1879.

Dr. Stevens in the chair. Eleven members present.

Dr. G. Hambach exhibited a fossil bird in excellent preservation, which he had just received from Colorado.

Mr. Nipher exhibited the portable electrometer of Sir William Thomson, and explained the theory of its action.

The Corresponding Secretary then made his

ANNUAL REPORT FOR 1879.

To the President of the Academy of Science.

The operations of the Corresponding Secretary for the year 1879 have been conducted in like manner as in former years, and the result shows the continued prosperity of our foreign correspondence.

There have been received from the Librarian, during the year, 119 copies of the several numbers of the Transactions for sale or exchange; and of these, 105 copies have been disposed of in the way of exchange, and 8 copies by sale, leaving 6 copies in hand.

There have been added to the Foreign List of exchanges 14 societies and individuals, and to the Home List 10, making a total of 24.

The whole number of names on the Foreign List, at the present time, is 245, distributed as follows: Sweden and Norway, 4; Russia, 9; Denmark, 3; Holland, 11; Germany, 101; Switzerland, 11; Belgium, 9; France, 26; Italy, 18; Spain, 3; Portugal, 2; South America, 8; Mexico, 5; East Indies, 6; Great Britain and Ireland, 29.

The whole number on the Home List is 110 (U. States, 101; British Provinces, 9).

The total number of exchanges is, then, 355, to which our Transactions are regularly sent as issued, and from the greater part of which their publications are received in return.

A full list of the publications that have been received through the Corresponding Secretary, since the printing of the last number of the Transactions, will appear in No. 1 of vol. iv., shortly to be issued.

Our foreign exchanges are conducted mainly through the Smithsonian Institution and its Agencies (as heretofore) at a moderate expense to the Academy. By this means, our operations are greatly facilitated: otherwise, the expense would probably be greater than the Academy could sustain from its present resources.

The whole number of Corresponding Members now upon the list (elected since the foundation in 1856) is 174. The number of those who are deceased has not been accurately ascertained. One only has been added to the list during the past year.

The publication of No. 1 of vol. iv. of the Transactions (delayed for some months for the completion of papers deemed important to be included) will not need to be much longer postponed. It will bring the report of our proceedings down to the end of the year 1879.

The account of the Corresponding Secretary for the year 1879 is herewith submitted in detail, showing a total of receipts of $35.75 and expenditures $31.11, leaving a balance in hand of $4.64.

Respectfully submitted, NATHANIEL HOLMES,
January 5th, 1880. *Corr. Sec'y.*

The Treasurer, Dr. E. Sander, then submitted his report, of which the following is an abstract.

The receipts for the year were $710.20, of which $216.39 were donated by the Executive Committee appointed to arrange for the reception of the American Association for the Advancement of Science, and $482.40 were received from members as annual dues.

The expenditures amounted to $554.87, by far the larger part of which, viz. $464.79, were used towards paying for a new number of the Transactions. This leaves a balance in the treasury of $261.18.

Mr. F. M. Crunden, Librarian, reported the following additions to the library: Volumes, 318; pamphlets, and parts of volumes, 836; sheets, maps, etc., 186.

The President, Dr. George Engelmann, then made his Annual Address, as follows:

Gentlemen of the Academy:

The expectation expressed at the last annual meeting, that soon we would be able to meet in our own Hall, has not been realized. Its happy fulfilment has been delayed for causes not under the control of your officers or your committee. But it is understood that the authorities of Washington University have declined other offers for the disposition of the old Mary Institute property on Lucas place, and that the offer they made to us a year ago is still open to us.

We ought to be able to avail ourselves soon of this advantageous opportunity to acquire a home—a home without which we will continue to linger along in the present unsatisfactory manner.

But it will be necessary to raise not only the $25,000 asked for the property, but also to raise a fund of the same amount, part of which to enable us to put the building in a proper condition for our purposes, erect cases for our specimens and for our library, bind our thousands of scattered volumes, and thus make them accessible to the members and to students generally. Another and greater part might be put aside as a permanent fund, from the interest of which the current expenses of the Institution for Curator, Janitor, light, fuel, repairs and other smaller items would have to be met, as our regular income from the contribution of members will be needed for the publication of our Transactions.

Does the large, wealthy and progressive city of St. Louis contain appreciation of scientific pursuits and necessities, combined with public spirit, enough to raise such a comparatively small sum?

It is believed that the first $25,000 necessary for the purchase of the property are almost ready, but that they have been subscribed only conditionally. and will not be available unless the second equal and absolutely necessary sum can be brought together.

Every day's experience shows how intimately science is connected with practical life and how necessary one is to the other. In the New England States this has long since led to great results. Quite lately the great commercial metropolis of our Atlantic border has awakened to the same conviction, and while years ago New Yorkers almost ignored the obscure existence of their New York Lyceum, they have at present one of the best endowed and splendid institutions of Natural History, fostered both by city and State in the most liberal manner. Can not, will not the commercial metropolis of the Mississippi valley imitate such a noble example? It seems that the returning general prosperity of the country should enable the friends of Science in St. Louis to base our institution, which we have carried on through a quarter of a century, contending with difficulties and adversities — to base it, I say, on a permanent foundation, promising a prosperous future.

The members of the Academy consist now of 2 Life and 104 Associate Members. During the year 4 new members have been added; 3 we have lost by death, and 4 by resignation or removal.

The Treasurer reports an income of $710.20 during the past year, $216.39 of which were donated to the Academy by the Committee of Reception of the American Association of Science, being a surplus from the fund collected for the meeting of August, 1878, in this city. The expenses, principally for printing, were $554.49; so that, with the balance of the year before ($105.83), we have now in the treasury remaining $261 14.

The Corresponding Secretary reports 174 Corresponding Members now living, as far as ascertained, one only having been added during the year.

The whole number of our foreign exchange list is now 245, and of our home list 110, together 355, to whom we send our publications and from whom we receive theirs, mainly through the mediation of the Smithsonian Institution, without which such an intercourse would be nearly impossible.

The Librarian reports an addition to our library during the past year of 318 volumes, 836 pamphlets and parts of volumes, and 186 sheets, loose maps, etc.

The first number of the fourth volume of our Transactions is nearly through the press and will be issued in a few weeks. It is believed that it will furnish valuable addition to the scientific literature of the day.

I am sure that I express the sense of every member of our Academy, when I offer my heartfelt thanks to the officers, my colleagues, and especially to our efficient Secretaries, both the Corresponding as well as the Recording Secretary, and express the hope that they may permit us to continue them in their laborious trusts.

As for myself I thank you heartily for your continued confidence, but wish that you would select a younger and more efficient person to preside over your Institution.

Mr. F. E. Nipher then made the following communication on

THE ELECTRIC LIGHT.

In the Philosophical Journal for January, 1879, Mr. W. H. Preece gives a discussion in which he shows the condition to be supplied in electric lighting, in order to obtain a maximum effect. Starting with equation 2, p. 31, we have for the heat distributed to the incandescent material,

$$H = \frac{E^2 l}{(p + r + l)^2}$$

where p represents the battery resistance, r the resistance of connecting wires, and l the resistance of a single lamp.

For n lamps joined up in series we must put nl for l, and if joined in multiple arc we must put $\frac{l}{n}$ for l, in the above formula. In either case, the value of H is found to be a maximum when the resistance of the lamp system is equal to that of the rest of the circuit.

Mr. Preece then proceeds on the assumption that this condition cannot be supplied when n is large, reaching the conclusion than when n is large the amount of heat generated in each lamp varies inversely as the square of the number of lamps.

This is true in either of the two special cases discussed by him. If, however, we have n lamps arranged in n' parallel circuits, in each of which we have n'' lamps, the previous equation becomes

$$H''' = \frac{E^2 \frac{n''}{n'} l}{\left(p + r + \frac{n''}{n'} l \right)^2}$$

With this arrangement, it is *always* possible to supply the condition which makes H''' a maximum, entirely irrespective of the value of n. This condition is

$$p + r = \frac{n''}{n'} l$$

where

$$n'' = \sqrt{\frac{n(p + r)}{l}}$$

Hence, when this condition is supplied, the heat given out in the lamp system becomes

$$H''' = \frac{E^2}{4(p + r)}$$

which is independent of the value of n.

The heat generated in each lamp will then vary inversely as the number of lamps.

C. V. Riley and Chas. Rau were elected to corresponding membership.

Election of officers for the ensuing year then took place, with the following result:

President—George Engelmann.
First Vice President—C. Shaler Smith.
Second Vice President—Albert Todd.
Corresponding Secretary—Nathaniel Holmes.
Recording Secretary—Francis E. Nipher.
Treasurer—Enno Sander.
Librarian—F. M. Crunden.
Curators—G. J. Engelmann, G. Hambach, W. B. Potter.

January 19, 1880.

The President in the chair. Thirteen members present.

The Corresponding Secretary read letters from C. V. Riley and Chas. Rau, acknowledging their election to corresponding membership.

The Corresponding Secretary presented a paper from J. Cochrane, of Lewiston, Pa., on the "Coal Formations of America," which was referred to the Committee on Publication.

Dr. Engelmann made the following remarks on the temperature of the month:

Last October was the warmest October in 45 years, November was warmer than the average, and December a little colder than the mean for the month: but now we have a January which thus far exceeds in mild temperature any we have had in this long period. The mean temperature for January here in St. Louis is a little less than 32 degrees, but thus far, in the first 19 days of the month, we have had a mean temperature of nearly 48 degrees, and 11 successive days (from the 2d to the 12th) without any frost. Previously the warmest Januarys had only 5 and 7 successive days without frost. The warmest Januarys I have ever observed here were those of 1845 and 1858, both with 40°.5. The next 12 days of this month may depress the mean temperature yet, but it is likely that it will still be much higher than the highest mean ever observed by me.

You will recollect the prediction of a cold winter with which we were treated a few months ago. The warm October would surely be followed by an unusually cold winter, and Indians and wild beasts—and, I believe, plants also—were hauled up to confirm the prediction; but, then, the winter is not yet over, and we do not know, cannot know, cannot predict, what the next four or six weeks may yet bring us.

I can tell you, however, that the warmest Januarys I have experienced here were followed in 1845 by a still warmer February; but that of 1858 was succeeded by a very cold February, the mean of January, 40°.5, falling to the mean of February, 27°.2, more than 13 degrees. And though on an average February is 3½ degrees warmer than January, we have not rarely seen it 8 to 12 degs., and in 1838 even 14 degs. colder than January.

The remarkable cold weather experienced in Europe, especially in the the west and south of Europe, while northeastward, in Northern Germany and in Russia it has been rather mild, is a phenomenon which, in connection with our mild winter, must stimulate meteorological research and speculation. But as to prediction, does not this abnormrl winter prove that, thus far, prediction has as signally failed as the so-called spiritual revelations? What precautions would not have been taken in European countries if that disastrous summer climate with its cold rains and miserable harvests, and if that cold winter with its ice and snow and its consequent floods and its suffering, could have been predicted or only guessed at!

We, ant-like, gather isolated facts in all parts of the globe, and may hope that some one who comes after us may in them discover the guiding principles and build up meteorological theories which will explain what now are only startling mysteries.

Dr. Engelmann also read the following note on the *Catalpa speciosa*, exhibiting specimens of the seed pods of the two varieties growing here, and of a Japanese variety.

A native catalpa was found growing in Southern Illinois, Indiana and Southeast Missouri, and was called "Shawnee wood" by the early French settlers. on account of its use by the Shawnee Indians. Michaux knew this tree ninety years ago without distinguishing it from the old species found in Georgia. Forty years ago a number of them were growing on Main and Second streets, in the gardens of Chouteau and the Catholic Bishop, and a few are still standing on Third street near Plum, and others in different parts of the city. This variety is botanically different from the majority of catalpas found in the city now. It is of larger growth, with larger and more showy blossoms, and it blooms from one to two weeks earlier. In the forests of Missouri it attains a height of sixty feet; the trunk is straight, and it is altogether a most beautiful tree. New Madrid is the centre of its geographical distribution. It grows rapidly, and is almost indestructible in water. Gate-posts on the farm of the late President Harrison, in Indiana, have been standing for eighty years. The wood admits of a fine polish, and the sap-wood becomes heart-wood in two or three years, whereas it takes the cedar twenty-five years to attain its durable quality. No better wood could be found for railroad ties if the wood turns out to be solid enough to bear the shock, and the railroads are already preparing to use it for this purpose. It should be planted on our prairies, where it would be found a most valuable tree for many purposes.

Mr. Nipher read a lecture on "Choice and Chance."

Mr. Chas. M. Scott was elected to associate membership.

February 2, 1880.

The President in the chair. Ten members present.

The Corresponding Secretary read by title a paper on "Planetary Configurations on Cyprian Antiquities," by Dr. G. Seyffarth, which was referred to the Publication Committee.

Dr. Engelmann gave a verbal statement of the temperature for the past month, which was the warmest January for many years. The mean temperature of the whole month was about 45½ degs., which was five degrees higher than he had ever seen it in January. With us it does not seem that vegetation has started much, but in the neighborhood of Iron Mountain honeysuckles were in bud, and in Arkansas apricots are beginning to bloom. The doctor then adverted to the cultivation of the western catalpa.

Dr. Engelmann reported that Prof. Sergeant of Massachusetts, superintendent of that portion of the coming census which refers to forest trees, has spent some days in this section. One of the interesting points was his visit to Southeast Missouri, where the catalpa grows. Near Charleston, Mississippi Co., Mo., he found this tree quite abundantly, and the Iron Mountain railroad is testing it for their purposes. It makes a fine and growing tree for our farms, makes excellent fence rails and posts, and can be utilized in many ways.

February 16, 1880.

Hon. A. Todd, Vice President, in the chair. Nine members present.

The meeting was devoted to business.

March 1, 1880.

The President in the chair. Eleven members present.

Miss Mary E. Murtfeldt read the following note on

IMMIGRANT INSECTS, ESPECIALLY THE EUROPEAN CABBAGE-WORM.

One of the most important as well as interesting questions with which the economic entomologist has to deal is that of the migration of injurious insects.

The tide of travel, with insects as with men, seems naturally to be from east to west. Occasionally there are examples to the contrary, as in the case of the Grape Phylloxera and the Colorado Potato beetle. With these two notable exceptions, however, Europe has not received from America any considerable pest to offset the almost innumerable noxious species that have immigrated to us from the other side of the Atlantic.

As a negative illustration of this natural progress from east to west may be mentioned the comparative scarcity of Asiatic species along our Pacific seaboard. With steamers plying regularly between our western ports and those of India, China and Japan, engaged in a varied and extensive commerce, it is remarkable that so small a percentage of oriental insect-fauna appears in our catalogues. At the same time, though isolated from the eastern States by arid plains of great extent and mountain heights of arctic cold and severity, our insects, including those from Europe, have nearly all found their way into the fields, orchards and vineyards of the Pacific States.

Among other interesting traits exhibited by these immigrant insects is their capacity for adapting themselves to climatic and other conditions so varied and so different from those to which they were indigenous. In many cases such adaptation is accompanied by noteworthy modifications of habit, and even, in a few species, of structure.

The latest invader from Europe which has appeared in our immediate locality is the Cabbage or Rape butterfly (*Pieris rapæ*, Schrank). More than ten years ago, in an article on the various " Cabbage-worms," Prof. Riley called attention to this insect, which had then appeared only in the vicinity of a few northern seaports, and predicted its spread westward and southward; with the further assurance that, once among us, it would prove vastly more destructive and difficult to eradicate than any of our native pests of the same family.

This prediction was abundantly fulfilled during the past summer (1879), much sooner than had been anticipated. From July to October the "green worms" were on every cruciferous garden vegetable—the second brood of the season, evidently—being thus numerous and destructive. In the flower garden also they made known their unwelcome presence. Here, singularly enough, they rejected the stocks, the sweet Hyssum, and the Candytuft, plants belonging to the botanical family which they most affect, in favor of the Mignonette, which belongs to an entirely different family. It is worthy of mention that this plant—the Mignonette—is likewise the only plant outside of the *Cruciferæ* upon which the larva of our most abundant indigenous species (*Pieris protodice*) will feed.

The perfect insect of *P. rapæ* is a delicate white butterfly of medium size, slow in flight and seldom rising high in the air. Both sexes bear a superficial resemblance to the male of our native *protodice*, but may be distinguished from it a glance by the more or less intense yellow color of the under-surfaces of the wings and their more conspicuous black tips.

There are probably three distinct broods of this insect in this latitude, though the longevity and continued fecundity of the butterflies make it very difficult to draw the line of demarkation between these broods. Larvæ of various sizes and in greater or less numbers may be found at any time from spring until late in autumn. Hibernation takes place in the chrysalis state. The unusually warm weather of the autumn of last year (1879) had the effect to bring out prematurely a large proportion of butterflies from the last brood, with which I was experimenting. This unseasonable emergence was likewise observed in the open air. These individuals did not, of course, survive the winter, and the spring brood would be thereby diminished. It is not unusaul for insects which hibernate in the pupa state to occasionally send forth a stray individual in autumn; but that so large a percentage of these butterflies should have developed only to speedily perish, shows, I think, the (as yet) imperfect adjustment of this insect to the climate of its new habitat. It may be safely predicted that fewer butterflies from the last brood will issue each successive year until they finally cease to do so altogether.

Many of the butterflies also came out during warm days in March this year, and found no flowers yielding honey for their own nourishment, nor any vegetation adapted to the needs of their progeny. They, consequently must have perished before they were able to do any damage. Having observed them carefully this spring, I am convinced that they will not oviposit on any of our early wild cruciferous plants such as *Capsella*, *Lepidium*, *Arabis*, and the like. They are, however, speedily attracted to hotbeds where young plants of cabbage, cauliflower, kohlrabi and allied species are growing, and these demand careful attention to prevent loss.

The Rape butterfly has already extended its range in this country from far north into British America to the south of Georgia, and there is no reason to doubt that it will be able to adapt itself to all the variations of soil and climate incident to such a wide area.

In Europe this pernicious insect is mainly kept in check by numerous parasites, some of which attack it in one stage of development and some in another. For several years after its advent into America none of these natural allies came to the aid of the disheartened gardener who was obliged to wage a single-handed warfare against it. After a few years several parasitic insects were observed preying upon it in the districts in which it first appeared. The most important of these parasites is a minute, metalic-green Chalcis-fly (*Pteromalus puparium*, Linn.), which is identical with the most destructive European foe of *P. rapæ*. This fly was at first supposed to have followed the butterfly to this country—conveyed in infested chrysalides, perhaps—but it has since been ascertained that it is indigenous on both sides of the Atlantic, from the fact that it has been found in localities where the Rape butterfly has not yet made its appearance. It was probably originally parasitic on the larvæ of the Northern Cabbage butterfly (*Pieris oleracea*), which closely resemble the European species.

The fly places its eggs in or upon the skin of the mature caterpillar. From these eggs proceed minute maggots, which subsist on the fatty tissues of their victim, but do not touch its vital organs until after it changes to chrysalis. Within the chrysalis shell they complete their transformations, the flies puncturing it in all parts when ready to emerge.

As the Northern Cabbage butterfly does not occur with us, we are less likely therefore to soon have the benefit of its parasite, unless, as might be easily done, it is introduced in infested chrysalides.

The artificial remedies consist of the application of hot water, whale oil soapsuds, or strong tar-water, to the plants suffering from the attacks of the caterpillars. Paris green and some other poisons in the form of powder will destroy the insects, but cannot be used with safety on vegetables whose foliage or flowers are used for food.

While, therefore, there is no longer much scientific interest attaching merely to descriptions of the appearance of this insect and to its ordinary history, its almost world-wide dispersion, the variations in habit which it exhibits in accommodating itself to diverse climatic conditions, the new parasitic and predaceous foes which it is likely to acquire after each important migration, and last, but not least, the losses which it is sure to occasion to the producing classes, combine to make it worthy of consideration by the scientist as well as the economist, and make it appropriate that its advent into the vicinity of St. Louis should be recorded in the archives of this Society.

Dr. Engelmann read the following note on the temperature of February and the past month:

After that extraordinarily warm January the past February seemed cold, but if we examine the records we find that its mean temperature was 39°.1, or nearly four degrees higher than the mean for February (35°.2) normally is; but we have had it warmer in February in former years eleven times, and in 1845 the mean for February reached 5 degrees higher, viz. to 44°.1.

The winter is now past, and in casting a glance at its mean temperature we find it exactly the same as the mean for February, viz. 39°.1, which is nearly 6 degrees warmer than the average winter temperature in St. Louis, viz. 33°.4. I find in 45 years only three winters as warm or warmer; they were those of 1844-5, 1875-6, and the past one.

	Winter 1845-6.	1875-6.	1879-80.	Average 45 years.
December	36°.6	41°.9	32°.5	33°.7
January	40 .5	39 .4	45 .6	31 .8
February	44 .1	39 .3	39 .1	35 .3
Mean winter temperature	40°.4	40°.2	39°.1	33°.4

From this little table it appears that in the first two mild winters the temperature of every month was proportionately above the average, while in the second one December was by far the warmest, and in the past one January exceeded both of the other months, and December remained below the average. The normal state of the temperature is that January is the coldest, December the next, and February the warmest of the three winter months.

The coldest weather in the whole winter we have just had was in December, when on the 25th the temperature fell below zero; and the river was full of running ice for the latter half of the month. But, just as in the past summer, we had no very violent changes—in other years not uncommon in our inland climate—and no excessive temperatures.

March 15, 1880.

The President in the chair. Nine members present.

R. S. Elliott presented a photograph of Auguste David's portrait of A. v. Humboldt, Paris, 1814.

The evening was devoted to business.

April 5, 1880.

The President in the chair. Fourteen members present.

Mr. Nipher made some experiments in thermo-electricity, making use of a Thomson galvanometer.

Dr. Engelmann remarked in regard to the progress of vegetation, that the effect of a warm winter like that which has passed is to make vegetation more forward in spring, even when the spring temperature is below the average. The buds do not appear *visibly* affected during the warm weather of the winter, nevertheless they open earlier in spring.

April 19, 1880.

The President in the chair. Eight members present.

Dr. Engelmann made some remarks on the cultivation of the cinchona tree in the British Possessions.

This tree grows native in the valleys of the Andes. The supply from that region is however diminishing, owing to the destruction of the trees. The English government has therefore begun the cultivation of the tree, having first determined by experiment at the Kew gardens which varieties furnish most quinine. Seedlings of the tree were sent from the Kew gardens to the mountains of Ceylon, Jamaica, and India, which furnish the moist and not too warm climate necessary for the growth of the plant. These regions are now furnishing large quantities of the bark. of a better quality even than the South American, and abundant seeds for propagation.

Mr. Nipher made a few remarks on the tornado of the 18th.

May 10, 1880.

The President in the chair. Forty members and visitors present.

Mr. Nipher read a paper detailing the results of his examination of the Marshfield tornado of April 18th, which was followed by a paper by C. Shaler Smith upon the same subject, these gentlemen having examined different parts of the path.

Dr. O. Pavy, who was present, was invited to address the Academy, and made a few remarks in regard to the Howgate expedition, which he is to accompany as surgeon and naturalist.

May 17, 1880.

Hon. A. Todd, Vice President, in the chair. Eight members present.

Dr. O. Pavy was elected to corresponding membership.

June 7, 1880.

The President in the chair. Seven members present.

Dr. Engelmann made the following remarks concerning the month of May:

The present May with its mean temperature of 71°.3 was, with one exception, the warmest May observed here, and was also remarkable as exhibiting no great extremes of temperature. The extremes were 41°.5 and 89°.5. The temperature of the three warmest Mays was—1860, 72°.1; 1870. 70°.2; 1880, 71°.3. All others lie between 60° and 70°.

Dr. Hambach exhibited a new species of Melonite and spines of *Melonites crassus*, and announced a paper in description of these fossils.

October 4, 1880.

Dr. I. Forbes in the chair. Eight members present.

The Corresponding Secretary presented a paper by Dr. Seyffarth on the "Hieroglyphic Tablet of Pompeium," which was referred to the Publication Committee.

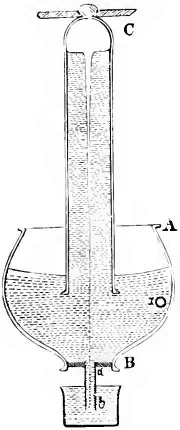
Mr. Nipher read a paper giving results of the magnetic survey of Missouri during the summer of 1880.

October 18, 1880.

Hon Chas. Speck in the chair. Fifteen members and visitors present.

Mr. Nipher made an experiment showing the formation of a vortex in water, a section of the apparatus being represented in the cut.

A wide-mouth receiver (*A B*) with a tubulure (*d*) is placed with the latter down, and a glass tube (*b d*) with cork is fitted into the tubulure, which thus serves for an escape for water. Water is run into the receiver by a rubber tube (*a*), so arranged as to throw the water into rotation. The water was run in from the hydrant with a pressure of 50 or 60 ft. A tall, narrow bell glass (*C*) was then placed centrally over the vortex formed, as shown, and an exhaustion of the air in *C* then took place, the water rising in *C* until the whole length of the vortex was about 30 inches. Its diameter at the top was about half an inch and it rapidly diminished in size, becoming apparently not over a tenth of an inch in diameter at a depth of six inches, and at the bottom (as the limit of exhaustion was reached) the vortex was represented by a fine filament, the lower end of which was continually breaking off and passing rapidly down the discharge tube. When the bell glass (*C*) is not symmetrically over the discharge tube, the vortex is more or less curved and sways slowly in a most beautiful manner. Cochineal tincture poured into the outside vessel, or bits of wood introduced into the mouth of *C*, show the path of the water particles around the vortex. A thin splinter introduced into the discharge tube mounts quickly to the top with the shortening vortex when *b* is closed for a moment, and darts quickly down again when *b* is opened. It is intended to arrange the apparatus so that three or more of such vortices can be made in one vessel, in order to show how they act upon each other under various circumstances. The beauty of the experiment was marred somewhat by reason of the turbidity of the hydrant water. In making the experiment care should be taken to make the tube *b d* fill with water. The velocity of outflow can be regulated somewhat by plunging the tube *b* into a vessel of water, bringing the lower end of the tube near the bottom. If desired, the tube can also be throttled by a perforated cork.



C. Shaler Smith exhibited an interesting specimen, being the head of a pile of resinous pine which had been driven by a pile-driver weighing 4,700 lbs., delivering 300 blows per minute. The top of the pile had been encircled by an iron ring, and just below the ring the fibre of the wood had been upset, and the heat developed had set the wood on fire, so that the whole top burned off and could be lifted off as a cap.

Dr. T. G. Comstock was elected to associate membership.

November 1, 1880.

Dr. E. Sander in the chair. Five members present.

The Corresponding Secretary presented a collection of papers from the Transactions of the American Institute of Mining Engineers—the gift of Edwin Harrison—which were accepted with a vote of thanks.

The evening was devoted to business.

November 15, 1880.

Hon. A. Todd in the chair. Nine members present.

Mr. Holmes made some remarks on the antiquity of man in the Rocky Mountain region.

Mr. Nipher explained the action of the Bell photophone.

December 6, 1880.

Dr. Geo. Engelmann, President, in the chair. Nine members present.

Mr. Nipher made the following report on the

METEOROLOGY OF NOVEMBER.

The November just passed has been remarkable for the low temperature reached, it having been the coldest ever observed in St. Louis. The mean temperature at the University was 34°, although two other stations in St. Louis gave a mean of 32°.1.

Previous to this year, the lowest *mean* November temperatures observed by Engelmann were — 1838, 34°.7; in 1872, 36°.1; in 1858, 37°.6, and in 1842, 37°.7. Twelve times since 1837 the temperature has fallen below 40°, while in 1849 the mean rose to 51°.8. The average November temperature is 42 9.

The coldest November temperature observed by Engelmann *at any time* was minus 0°.5 in 1845, although the mean of that month fell only 0.°2 below the normal (42°.9). During last month, in S.W. Missouri, the temperature and the mean temperature have been lower than were ever observed at St. Louis. The coldest temperature in the State is reported from Neosho. namely, —16° on the 18th (and —4° and —6° on the 17th and 19th), while the average for the month at that station is 30°.9. Only one other station reports a lower mean, viz. Oregon, 28.8; but the coldest *temperature* observed at Oregon was +5°. This extreme cold extended to other points in South Missouri (on the 18th), the temperature in the north part of the State averaging 15 degs. higher; thus, on the 18th the minimum at 7 A.M. readings were—

			Central.		North.	
Neosho, min.		—16	Chamois,	—8	Corning,	+6
Salem,	7 A.M.	—12	Warrensburg,	—6	Oregon,	+5
Springfield	5 "	— 9	Boonville,	—2	Keokuk, above	+3
Ironton,	7 "	—13				
Cuba, min.	6¼ "	— 4				

The rainfall at St. Louis was 3.24 (normal 2.95), the greater part here. as in the State, falling before the 15th. In S.E. Missouri the fall has exceeded 5 inches. In the rest of the State, excepting along the Missouri valley from Kansas City to near Glasgow (where the fall was over 2 in.), the fall has been between 1 and 2 inches.

Dr. Engelmann made a few remarks on graphical methods of representing the characteristic features of a temperature series.

December 20, 1880.

Dr. Engelmann in the chair. Sixteen members present.

Dr. Engelmann gave a brief account of his work during last summer among the forests of Oregon, Arizona, and California as far south as the Mexican boundary. This work has been done for the U. S. census, and was done in company with Dr. Parry and Prof. Sargent. The forests of California are very fine, and composed mostly of coniferous wood. Timber for wagons and wine barrels is imported from the east, and some timber is obtained from Mexico. The red-wood, which grows to a great size, is much used, and will soon be exhausted.

Dr. L. P. Pollman was elected associate member, and Dr. J. L. R. Wadsworth, of Collinsville, Ills., was elected to corresponding membership.

January 3, 1881.

Dr. Geo. Engelmann in the chair. Ten members present.

The Corresponding Secretary read a letter from Dr. Wadsworth, acknowledging his election to corresponding membership.

The President, Dr. Geo. Engelmann, then made his annual address as follows.

Gentlemen of the Academy of Science :

Retiring from the Presidency of your Institution, with which you have honored me for the last three years and often before that period, I have to lay before you a statement of the present condition of our Academy, accompanied with such remarks and suggestions as may offer themselves. You will pardon me if I refrain from adding to these matter-of-fact points a review of the stupendous progress of science in the past year, and from suggesting what the duty is, or ought to be, of a city of the importance and fame of St. Louis, and of those of her citizens who claim to be progressive men, relative to the encouragement and aid of labors voluntarily and gratuitously undertaken by you.

In the past year meetings have been regularly attended, and were made interesting and instructive by communications of a scientific character and by discussions on them. You have published the first number of the fourth volume of your Transactions, full of various scientific contributions, which have been favorably received in this country and in Europe, thus spreading through its Academy the name of St. Louis in all civilized lands.

Besides this number of your Transactions the Anthropological Section of your Academy has published part first of their Archæology of Missouri, a quarto volume with excellent plates, on the Pottery of the Mound-builders, an important addition to the knowledge of prehistoric times. Three hundred copies of this work have been subscribed for by the Academy, and have been in part distributed by the Corresponding Secretary.

Your collections have not been enriched as much as they might have been, principally because of the want of room and of a proper disposition of specimens; your library, however, has received most valuable additions through the exchanges which you obtain for your own publications from almost all scientific bodies throughout the civilized world. The Librarian reports under his charge 3,253 books and 7,834 pamphlets, 995 of which have been added within the year.

The Corresponding Secretary reports an exchange list of 372 Academies and Societies, 120 of which belong to this country and the American British Provinces; of the 252 of other countries, 103 are in Germany, 30 in Great Britain, 27 in France, 18 in Italy, 12 in Holland, 11 in Switzerland, 10 in Belgium, 9 in Russia, 8 in South America, 6 in the East Indies, 5 each in Mexico and Sweden, 3 each in Denmark and Spain, and 2 in Portugal.

The number of your Associate Members amounted in the beginning of the year to 104; 3 of these have removed from the city or have resigned, and 3 others have been added to the list, so that the number of members has remained stationary.

The finances of the Academy are flourishing on a small scale; the Treasurer has been able to liquidate all debts and has a surplus on hand of $149.42, which, when the outstanding debts due to the Academy from members, and which are almost all considered perfectly safe, shall have been paid in, will enable you to go on with your publications, and these are the important links which connect your Institution with the scientific world abroad.

In former annual reports I have dwelt on the necessity of obtaining a home for the Academy, which at present owes to the enlightened liberality of the School Board the possibility of meeting at all. I had then spoken of possibilities in view, and flattered myself and you with the probabilities of success. But you are now in this respect not farther advanced than you were years ago, and it is left to your wisdom and your energy to lead the Academy to a more promising and a more prosperous future. You want a home and you must have a home where your most important library can be properly exhibited and made useful, where a museum may be established, valuable elements of which are already in your possession, and where visitors as well as citizens may enjoy and instruct themselves.

The Corresponding Secretary then presented his annual report, of which the following is an abstract.

Of the 300 copies of the Monograph on Missouri Potteries, 151 have been distributed to societies and academies more especially interested in anthropology or archæology, 2 copies are yet in the hands of the Corresponding Secretary, and the rest are deposited with the Librarian.

The Corresponding Secretary has also received 440 copies of No. 1, vol. iv. of the Transactions, of which 422 have been sent to exchanges, 16 sold, and 2 remain in the hands of the Corresponding Secretary, the remainder of the edition being deposited in the library.

Mr. E. Sander, Treasurer, also made his annual report, by which it appeared that the total receipts from all sources during the year was $624.47, and total disbursements $475.05, of which $401.53 was for the completion of No. 1 of vol. 4.

Election of officers then followed, resulting as follows:

President—George Engelmann.
First Vice President—C. Shaler Smith.
Second Vice President—M. L. Gray.
Corresponding Secretary—Nathaniel Holmes.
Recording Secretary—Francis E. Nipher.
Treasurer—Enno Sander.
Librarian—Frederick M. Crunden.
Curators—G. Hambach, Edw. Evers, W. B. Potter.

Mr. Fred'k Ruschhaupt was elected to associate membership.

January 17, 1881.

Dr. Engelmann in the chair. Eleven members present.

Mr. Nipher exhibited a raised map of Missouri, showing the general features of topography. Upon this surface the lines of equal variation of the magnetic needle had been drawn to represent the observations at 45 stations in the State. The results seemed to indicate a marked relation between contour and the position of the needle.

Some discussion then arose on the relation between the age and diameter of trees. It was stated by Dr. Engelmann, that conifers in California, 6 ft. in diameter, were from five to six hundred years old. The inner rings of growth are generally thicker than the outer ones. It sometimes happens that young trees are shaded by older ones, and grow more rapidly after the overshadowing trees have fallen.

February 7, 1881.

Dr. Engelmann in the chair. Eight members present.

The Corresponding Secretary presented a paper by C. V. Riley, entitled "Notes on North American Microgasters, with Descriptions of New Species," which was referred to the Cmmittee on Publication.

He also reported a donation of papers on mining by Mr. Edwin Harrison, for which the thanks of the Academy were voted.

Mr. Richard Hayes made a few remarks on the periodicity of earthquakes, in which he stated that the present year would be one of maximum frequency.

Mr. D. S. Brown was elected to associate membership.

February 21, 1881.

Dr. Engelmann in the chair. Nine members present.

Mr. A. Leonhard exhibited some pseudomorphs, showing the process of replacement in various stages. One specimen showed a partially dissolved scalenohedron of calcite, with a form of limonite around it. Other specimens shown were calamine after calcite, and serpentine after garnet.

Mr. E. A. Engler was elected to associate membership.

March 7, 1881.

Vice President M. L. Gray in the chair. Nine members present.

Mr. Nipher called attention to some recent experiments of Dr. Carnally on "hot ice."

March 21, 1881.

M. L. Gray in the chair. Thirteen members present.

Dr. C. A. Todd called attention to the increasing use of oleomargarine and "lardine" as butter, and read extracts from reports giving impurities revealed by microscopic examination.

Dr. Todd also gave a description with drawings of a variation in the form of the digastric muscle of a child, to a form which is stable in the monkey. This paper was requestedfor publication.

The Corresponding Secretary also presented a paper from C. V. Riley, entitled "Description of some New Tortricidæ," which was referred to the Publication Committee.

April 4, 1881.

Dr. Engelmann in the chair. Sixteen members present.

Dr. Engelmann made a communication on the temperature of March.

E. S. Holden, Director of Washburn Observatory, Madison, Wis., and Henry Phillips, Jr., of Philadelphia, were elected to corresponding membership.

J. L. Buskett was elected associate member.

April 18, 1881.

Dr. Engelmann in the chair. Twelve members present.

Dr. Wadsworth of Collinsville read a paper on the temperature of the American Bottom near Collinsville, compared with the temperature at Collinsville and St. Louis.

Mr. Nipher read a paper on "Certain Problems in Refraction."

These papers were referred to the Publication Committee.

Dr. Ferdinand v. Hochstetter of Vienna was elected to corresponding membership.

May 2, 1881.

A. Todd in the chair. Eight members present.

Edwin Harrison donated "The Anniversary Memoirs of the Boston Society of Natural History, 50th Anniversary," for which the thanks of the Academy were voted.

Mr. Nipher showed the fusion of ice at 0° C. when under under pressure above one atmosphere.

He also showed on the screen, by means of a lantern, the tracing of a compound pendulum, the figure being projected while forming.

G. C. Stone was elected to associate membership.

May 16, 1881.

Dr. C. A. Todd in the chair. Sixty-five members and visitors present.

Mr. E. A. Engler gave a lecture on Standard Time systems in Europe, describing in particular the methods of distributing time signals in London and Paris.

Prof. J. K. Rees gave a short lecture on the proposed adoption of standard time meridians in this country.

On motion of Prof. Rees, the Academy voted unanimously to endorse the plan of standard time meridians now being advocated by the Metrological Society, and recommended that $6^h\ 0^m\ 0^s$ west of Greenwich be adopted as standard St. Louis time.

Dr. W. G. Eliot, Chancellor of Washington University, was elected to associate membership, and Carl Ritter von Hauer and Dr. Hann, of Vienna, were elected to corresponding membership.

June 6, 1881.

Dr. Engelmann in the chair. Twelve members present.

Dr. Stevens exhibited some specimens of sharks' teeth from the phosphate beds of South Carolina. The phosphates from this region are largely used as fertilizers, and contain large numbers of sharks' teeth.

Dr. Engelmann remarked that the past spring had been cool in March, vegetation being considerably retarded. April had a temperature nearly normal, while May was unusually warm, so that now vegetation is about normally advanced. Fruit trees bloomed later than usual, and all bloomed at about the same time.

The Corresponding Secretary read a communication from Dr. Seyffarth on the New York obelisk.

June 20, 1881.

Dr. Engelmann in the chair. Eleven members present.

The Corresponding Secretary read a letter from Dr. von Hochstetter, acknowledging his election to corresponding membership.

Dr. Engelmann presented a report on the climate of San Luis Potosi, Mexico:

The range of temperature on the high plateau upon which the city is situated is small. In spring the temperature ranges from 32 to 80, and in summer from 55 to 73. The annual rainfall is only twelve inches.

October 3, 1881.

Dr. Engelmann in the chair. Eight members present.

A letter of acknowledgments from Dr. von Hauer, lately elected corresponding member, was read by the Corresponding Sec'y.

Dr. C. A. Todd presented a specimen of elephant's milk, obtained from the elephant mother in Barnum's menagerie, and gave an account of the case, which is the first one of an elephant being born in captivity. At birth the young was 35 inches in height, and now at the age of 20 months is about 57 inches in height. The milk has a strong flavor and odor, much resembling that of the cocoanut.

Mr. Nipher gave a report on the results of a magnetic survey made during the past summer.

Wm. H. Markham and C. F. Kirchner were elected associate members.

October 17, 1881.

Dr. C. A. Todd in the chair. Six members present.

The evening was devoted to business.

November 7, 1881.

Dr. Engelmann in the chair. Five members present.

Dr. Engelmann read a paper on *Isoëtes*.

Dr. O. A. Wall and Prof. H. S. Pritchett were elected associate members.

November 21, 1881.

Dr. Engelmann in the chair. Twelve members present.

The Corresponding Secretary read a letter of acknowledgments from Dr. J. Hann, lately elected to corresponding membership.

Dr. Briggs exhibited specimens of *Lithostrotian canadense* from the St. Louis limestone.

Mr. Potter read a note on the results of an examination of specimens of Geyserite from the region of the Yellowstone. The specimens were — No. 1, a cauliflower variety; No. 2, a pearly variety, and No. 3, a pseudomorph afterwood. The results of an analysis gave

	No. 1.	No. 2.	No. 3.
Moisture	5·58	4·37	2·61
Lost by ignition	7·77	8·50	13·676
Silica	82·66	83·89	81·94
Iron and Alumina	2·28	2·27	1·12
Lime	1·128	0·318	0·41
Magnesia	trace	trace	trace
Alkalies	0·364	0·514	0·244
Sulphuric Acid	trace	trace	trace
	99·782	99·862	100.00

A combustion analysis shows that 3.38 per cent. of the 13.676 per cent. loss by ignition in the pseudomorph is carbon. Calculating from the general formula for wood

$$(C,\ 49._1\ ;\ H,\ 6._3\ ;\ O,\ 44._6),$$

we have 6.88 per cent. of wood remaing in this specimen.

By way of comparison the following analyses of Geyserite from other localities were submitted:

	Iceland, by Forchhammer.	New Zealand, by Mallet.
Silica	84·43	94·20
Alumina	3·07	1·58
Ferric Oxide	1·91	0·17
Lime	0·70	trace
Sodium Chloride	......	0·85
Water	7·88	3·06
Alkalies	0·92	....
Magnesia	1·06	....
	99·97	99·86

Mr. Pritchett presented a paper entitled "Ephemeris of the Satellites of Mars for the Opposition of 1881."

Chas. Ludeking was elected associate member, and George C. Pratt was elected corresponding member.

December 5, 1881.

Dr. Engelmann in the chair. Nineteen members present.

Geo. W. Lettermann, of Allenton, presented specimens of tree-trunks of woods from Arkansas. The specimens were *Xantho-*

xylum clava-Herculis, or Prickly-ash, the trunk being covered with corky cones — locality Little Rock; *Sambucus canadensis*, or common Elder, five inches in diameter, from Newport; *Benjoin odoriferum*, or Spice-wood, four and a half inches in diameter, from Newport; *Forestiera acuminata*, or Water Privet, eight inches in diameter, from Newport; *Alnus serrulata*, or Alder, four inches in diameter, from Nevada Co. Mr. Lettermann remarked that Sassafras attains a diameter of four and a half feet in south-east Missouri and Arkansas, growing, like Spice-wood, only in rich soil.

Mr. Nipher presented a copper-plate portrait of W. von Haidinger.

Mr. W. McAdams, of Jerseyville, Ills., exhibited copper implements and ornaments found in Illinois mounds.

Dr. Washburn exhibited an arrow-point taken from the femur of a mound skeleton. He remarked that the bone gave evidence that death had occurred long after the wound had been inflicted. The arrow-point was found to be comparatively soft like chert. He thought the arrow must have been much harder in order to have entered the bone.

Mr. E. A. Engler described an auroral phenomenon seen by him off the Atlantic coast.

December 19, 1881.

M. L. Gray, Vice-President, in the chair. Eight members present.

Mr. Nipher, in behalf of Dr. W. G. Weaver, of Bolivar, Polk Co., Mo., presented an English edition of the complete works of John Rudolph Glauber. The edition is a translation from the original German edition, and many of the illustrations are from the original copper-plates. The work bears the date of 1668. Mr. Nipher remarked that the book had been owned by Joseph Draper, of Perquimans Co., N. C., who bought it "y^{e} 12th of 6th month 1780. Price was 100 dolars at about 1½ pence each." The after history of the book is partly recorded on the blank leaves.

January 3, 1882.

Dr. Engelmann in the chair. Twelve members present.

The President made his annual address as follows.

Gentlemen, members of the St. Louis Academy of Science:

With sincere pleasure I congratulate you that on this, your twenty-fifth anniversary, you for the first time in twelve years meet in your own hall, surrounded by your precious library, and by the germ of a museum.

Very soon after the organization of the Academy on March 10, 1856, the liberality of your late member, Dr. Chas. A. Pope, gave you a hall in which to meet and rooms in which to arrange your library and museum in the building attached to the medical college on the corner of Myrtle and Seventh streets. In these rooms your Academy prospered until the fire of May, 1869, drove you out, almost entirely destroying the museum and severely injuring the library.

At this crisis the Board of Public Schools came to your aid, and you were granted by them, for the purpose of meeting, the great hall of the Polytechnic Building free of rent, and with free light and heat. But there was no room for the display of whatever might accumulate of collections, and your rapidly growing library scarcely found a shelter and was in no condition to be used. Under these conditions, and after an attempt to secure the possession of a hall of your own had failed, you, through the kindness of the Board of Trustees of Washington University, now occupy in the building of the institution your own comfortable rooms, free of rent and at a nominal expense for gas and heating.

Looking around, you now find your library neatly arranged on shelves, and find the cases along the walls destined to receive the collections which it is expected will now flow in, since a good beginning is now made. You must, at last, feel that you have a home where henceforth you may meet with comfort and work with the hope of success.

The expense of fitting up the hall and of the removal into it has been borne by private subscription among members and citizens of St. Louis, and the great work of arrangement has been performed with praiseworthy zeal and disinterestedness by the Curator, Dr. Hambach, and the Recording Secretary, Prof. Nipher, with the assistance of other members. But this is not all. To make this valuable library perfectly accessible and useful the books and journals must be bound, and funds for this purpose also will be necessary.

The Corresponding Secretary has continued his laborious work with wonted punctuality. He reports an increase of your exchange list, so that it now amounts to 260 in foreign countries and numbers 127 in the home list, viz., 117 in the United States and 10 in the British Provinces—in all 387, or 15 more than you had last year.

In the same period 9 associate members have been lost to the Academy by death, removal, or resignation, and 3 have been dropped for nonpayment of dues. Nine new members joined us in 1881, so that the Academy now has 99 associate members. A new number of your Transactions, the second of volume four, is now in the printer's hands and almost ready for publication, and matter for number three is rapidly accumulating.

Your Treasurer has thus far been able to meet the demands against him, principally originating in the publication of the Transactions; but it will be necessary that the members should liquidate their debts to the Academy with promptness to enable him to pay the printer's bills now about falling due. As yet you live, so to speak, from hand to mouth, but you have always been able to keep up your credit with the world of Science by the publication of your transactions, and must keep up your commercial credit and your existence by a proper attention to the claims of your Treasurer.

But in your new home it is expected that your meetings will attract greater public attention; you will draw around you the promoters and lovers of science in your city, the scientific zeal now awakening all over the land will also increase among us, the number of members will augment, and, with the new forces they will bring, the meetings will be more attractive, and the visible results of your work—your Transactions—will bear the name of your Academy, and of the city that fosters it, to all parts of the civilized world.

The Report of the Corresponding Secretary showed that seven new corresponding members have been added during the year and two have died, viz., John M. Bigsby, M.D., F.G.S., London, and James Robb, Esq., Cincinnati, Ohio.

The exchanges are now as follows:

Sweden	5	Russia	10	Denmark	3
Holland	12	Germany	104	Switzerland	11
Belgium	10	France	29	Italy	18
Spain	3	Portugal	4	South America	7
Mexico	6	East Indies	7	Great Britain	31
Prov. of Brit. Amer.	10	United States	117		

In behalf of Dr. Mudd, a collection of snakes from southern Illinois was presented to the Academy, and was received with a vote of thanks.

Dr. Engelmann remarked on the temperature of the year 1881, that it was one of the warmest we have had, although no month of the year except August was warmer than corresponding months previously observed. The drouth during the summer was marked, and came at a time when it did most harm. The amount of rainfall was not much less than the average. Dr. Engelmann also stated that the remaining months of the year would probably be warm, as in his experience a warm December is usually followed by a warm January and February.

Dr. Todd remarked that at St. Mary's, Canada, the drouth was so marked that the deep vegetable mould forming the soil burned in immense quantities, endangering buildings.

Election of officers for the ensuing year was then held, resulting as follows:

President—George Engelmann.
First Vice President—James M. Leete.
Second Vice President—M. L. Gray.
Corresponding Secretary—Nathaniel Holmes.
Recording Secretary—Francis E. Nipher.
Treasurer—Enno Sander.
Librarian—Gustave Hambach.
Curators—Gustave Hambach, Edw. Evers, A. Leonhard.

On motion of Dr. Sander, it was voted that Dr. Gustave Hambach be made a life-member of the Academy.

Dr. Sander explained that the motion was made as a recognition of the service which Dr. Hambach had rendered in arranging the library.

The motion was unanimously carried.

January 16, 1882.

Dr. Engelmann in the chair. Eight members present.

W. B. Potter exhibited a collection of native metals, mostly gold, silver and copper, exhibiting characteristics of their ocurrence.

Dr. Engelmann made a few remarks on the hot springs of Colorado:

The best and longest known are those of Idaho and Clear Springs, although they were smaller and much less important than others. Their temperature is about 100°, and the largest ingredient, as in all the springs of Colorado, hot and cold, is carbonate of soda. Some contain iron, others hydric sulphide, and others common salt, and some a slight mixture of purgative salt such as sulphates of magnesia or soda. but in small quantities.

At Canyon City, where the Arkansas breaks through the famous gorge, is another spring. These springs usually appear where the granitic rocks connect with the rocks of recent origin. At Canyon City the later rocks are lying on the same slope with the granitic ones, and the same is true of the Las Vegas and Middle Park springs, where the Grant river breaks through. The temperature of the Canyon City springs is about 100°.

The Middle Park springs were the most interesting. They are hot sulphur springs with a temperature of 112°. A good many small springs cluster in a space of a few square rods. and the discharge falls into a basin eight to ten feet deep. The springs are very medicinal, containing salts of soda. They are between forty and fifty miles from the railroad. A spring about six miles from Las Vegas, New Mexico, has a temperature of 120° to 125°.

Henry Blattner was elected to associate membership.

February 6, 1882.

The President in the chair. Nine members present.

Mr. Holmes made some remarks on the production of steel in the United States.

Mr. Pritchett made some remarks on the history of double-star work.

February 20, 1882.

The President in the chair. Eight members present.

Mr. Nipher presented a copy of Clerk-Maxwell's "Theory of Heat."

Mr. Nipher gave a short lecture on electric potential, illustrating the remarks with a plaster model representing the potential around two electrified spheres charged with unlike electricity.

Mr. Geo. G. Stone, of New York, was elected to corresponding membership; and Dr. Alexander Dienst, Dr. Joseph Spiegelhalter, and Mr. Frank Nicholson, Sup't of Copper Works, St. Genevieve, were elected to associate membership.

March 6, 1882.

The President in the chair. Eight members present.

Mr. Nipher made the following remarks on the storm of February 19th and 20th:

The great monthly rainfall of the central and south-west portions of Missouri during last month was due to the rains of the 19th and 20th, which in the region west of St. Louis amounted to six inches. In the northern part of the storm the rain froze upon the trees to the thickness of from half an inch to an inch, so that the ice-covering on small limbs would be two inches in diameter. This enormous loading of the trees resulted in immense destruction of fruit and ornamental trees. Telegraphic communication was absolutely cut off by the breaking of every wire in almost every span, and by the breaking of many poles.

In Johnson county the loss in trees is placed at half a million dollars. At Pleasannt Hill the weighing of ice-covered branches led to the result that a cedar tree, ten feet high and with branches spreading ten feet at the base, had received over four hundred pounds of ice. At Miami, Saline county, the loss in forest trees is placed at two per cent. of the cash value. Oak trees, eight to twelve inches in diameter and fifty to seventy feet high, were bent over so that the tops trailed upon the ground. Thousands of fruit and shade trees have not a single branch left. The same reports come from Clinton, Harrisonville, Glasgow, Macon, Mexico, Shelbina. This damage occurred over an area of about 5,000 square miles. In many cases the damage was increased by high winds which occurred during the four or five days that the ice remained upon the trees.

Mr. Holmes made a few remarks on the subject of potential.

March 20, 1882.

Dr. Engelmann in the chair. Ten members present.

A letter was read from Mr. Geo. C. Stone, with acknowledgments for his election to corresponding membership.

Mr. Pritchett gave an account of the railroad time service, in which time is daily distributed over ten thousand miles of railroad wire.

Dr. Todd exhibited an anatomical preparation of the human hand, showing the tendon of the ring-finger which prevented free movement in piano-playing. A similar preparation of the hand of a monkey was shown, and the similar tendons were shown to be much more fully developed in the monkey than in the human hand.

Dr. Engelmann exhibited a diagram showing the normal temperature for London for each day in the year.

April 3, 1882.

The President in the chair. Seventeen members present.

Mr. Engler gave a short lecture on cosmopolitan time systems.

Mr. Nipher read a paper entitled, "On a Property of the Isentropic Curve for a Perfect Gas, as drawn upon the Thermodynamic Surface of Pressure-Volume-Temperature."

April 17, 1882.

The President in the chair. Twelve members present.

Dr. Todd presented segments of the trunk of the elephant, and made some remarks on the anatomy of the same. He also exhibited the jaws and teeth of a young elephant, and explained the dentition of the animal and the structure of the teeth, by means of polished cross-sections.

Dr. Engelmann presented an orange containing another orange enclosed.

Mr. Leonhard presented a list of minerals found in Missouri, and called attention to some of the more important species.

He also exhibited a collection of meteorites containing one specimen which was supposed by Dr. Hahn to contain a fossil coral.

May 1, 1882.

Dr. Engelmann in the chair. Eight members present.

Mr. C. S. Smith presented a map showing the area covered by the tornado of April 18th, 1880, within the limits of the city of Marshfield.

Dr. Engelmann made the following communication on the temperature of the present spring:

The past April was not as warm in proportion as March or February, but still it has been $2._5$ degrees above the normal, so that since December every month of the five was above the normal, December and March giving the greatest excess, and January and April the least. The average of the five months was $4^\circ._6$ above the normal, and this in our variable climate is no unusual thing. Only two years ago we had just such a mild winter and an early spring, and after it the fruitful season of 1880.

Running over former records, I find the unexpected fact that for the last ten years we have had regular alternations of mild and cold winters. The cold winter of 1872-3 was followed by the mild one of 1873-4, although this was only 1°.3 above the average; but all the following winters show between five and seven degrees deviation from the normal, as is shown in the following table:

1872-73	26°.3	— 7°.2	1878-79	28°.4	— 5°.1
1873-74	34 .8	+ 1 .3	1879-80	39 .1	+ 5 .6
1874-75	26 .9	— 6 .6	1880-81	26 .6	— 6 .9
1875-76	40 .2	+ 6 .7	1881-82	39 .1	+ 5 .6
1876-77	30 .7	— 2 .8	1882-83	28 .9	— 4 .6
1877-78	40 .2	+ 6 .7			

The normal winter temperature is 33°.5 How these values can be harmonized with the supposed meteorological periods of 10 or 11 years, or how it can be explained, I must leave to others. To increase the difficulty I must add that in the previous ten years, from 1862 to 1872, about all the winters had temperatures differing little from the normal.

May 15, 1882.

The President in the chair. Ten members present.

Mr. Nipher made a final report on the cost of removal to Washington University, and at his request the subscription list and vouchers for expenditures were referred to a committee consisting of Dr. Sander and Mr. Tivy. The accounts were reported correct and the committee was discharged.

Mr. Nipher announced the completion of his report on the magnetic work of 1881, and the report was presented to the Academy.

June 5, 1882.

The President in the chair. Nine members present.

Dr. Engelmann reported that

the past month was among the coldest Mays since 1837, when his observations began. The mean temperature for May is 66°.3. Two years ago the May temperature was 71°.3 and only last year it was 71°.4, these being the highest May temperatures observed. This year, however, it was 60°.7. Only twice has the temperature of May fallen as low as this. In 1838 and 1867 it was as low as 60°.5. It is interesting to observe that in both years a hot summer followed the cool May, but, of course, no prediction can be based upon this fact.

Dr. Engelmann also presented two diagrams showing the average temperature for each day of the month of January and May for forty-seven years. The curves were much more irregular than corresponding curves for London, adjacent days frequently by two degrees.

Mr. Nipher made a short communication regarding the determination of the constant for a galvanometer;

Some years since the question of the measurement of earth currents in the Arctic regions came up, and it became desirable to know whether a copper electrode used in determining the constant for the galvanometer must be weighed soon, or whether with a reasonably strong current the weighing might be deferred until the return of the expedition. With a view of examining this point, a determination was made on February 1st, 1880. The current ran for $1^h\ 37^m\ 30^s$, depositing $0._{3211}$ grammes of copper. The electrode was then thrown loosely into the drawer of the balance, where it remained until April 4, 1882, when the same electrode was found to have gained $0._{0007}$ gramme in weight, showing thus no change of importance in two years.

June 19, 1882.

Dr. Engelmann, President, in the chair. Eleven members present.

G. W. Lettermann, of Allenton, presented specimens of the wood of the ***Planera aquatica*** from Nevada Co., Ark.,, and of the water-locust, *Gleditschia monosperma*, from Newport, Ark. He stated that

both belong more especially to the flora of the southern States. The water locust, however, makes its way up along the Mississippi river past St. Louis, and Mr. H. Eggert found it about Alton, Ills., which seems to be its northern limit. The Planera is a rarer tree, with very close grain. It does not seem to occur north of the lowlands of south-east Missouri. As they grow only in wet places, and rarely attain the size of a tree except in deep swamps, both species are scarce in collections, and are not well known even by woodmen in their native homes.

Mr. Leonhard gave a description of the mineral formations of Missouri.

Dr. Engelmann showed a specimen of a cactus, *Cereus gumenosa*, from Lower California, the pulp of which is mixed with oil by the natives and used as a calking for vessels.

October 2, 1882.

Dr. Engelmann in the chair. Ten members present.

Mr. B. A. Hill presented the Academy with twenty-three of the earlier numbers of the Transactions, which were received with a vote of thanks.

Mr. Nipher gave some of the results of the magnetic work during the past summer.

Dr. F. L. James was elected to associate membership.

October 16, 1882.

Dr. J. M. Leete, Vice President, in the chair. Six members present.

Mr. Leonhard showed the deposition of metallic iron by Klassen's electrolyptic method.

November 6, 1882.

The President in the chair. Twelve members present.

Dr. Engelmann read the following note on the climatology of St. Louis:

The mean temperature of St. Louis is $55^{\circ}.{}_{4}$, and April and October are the months the mean temperature of which approaches nearest to the annual mean, April showing a mean of $56^{\circ}.{}_{2}$ and October of $56^{\circ}.{}_{1}$; but in different years April as well as October vary exceedingly, and are often either colder or warmer than the mean.

The past month was considered, and justly so, as one of the warmest we have had since observations have been made. Its mean was $61^{\circ}.{}_{2}$ according to my observations, but we have had in 47 years four other years in which the mean reached over 60. Even last year, 1881, October was a little warmer than this year, and in 1839 and in 1852 the mean temperature rose to between 62 and 63 degrees. The coldest Octobers I have recorded were $47^{\circ}.{}_{1}$ in 1863 and $47^{\circ}.{}_{5}$ in 1869.

Of more practical interest is the appearance of the first frost in October. I record the first frost when the temperature of the air falls in the city to or below the freezing-point of water. White frost often appears with a higher temperature, say 34° or even 35°; and in the country, outside the limit of houses and smoke, a killing frost may appear much earlier than in town. Of that I have no reliable records. But here, within the city, no injury by frost has been done in the last October, and none to this day (Nov. 6), as anybody can satisfy himself by examining such tender plants as the castor bean, the tomato-vine, or the common bean, none of which are touched as yet. The lowest temperature last October was $39^{\circ}._{5}$, on the 20th. Since then the temperature has often been over 50°.

I find that in the last forty-seven years we have had no frost in October in twelve years. The warmest Octobers were those of 1852, when the lowest in October was 42°, and 1881, last year, when the lowest was 41°. In the first of these years the first frost occurred on Nov. 9th, and in the other not sooner than Nov. 15th. No frost has ever been observed by me in September. The earliest frosts of the season were recorded on October 4th, 1836, 31°; on October 7th, 1868, and October 11th, 1871, both $31^{\circ}._{5}$. After October 11th frost has set in in many years. The lowest temperature ever observed by me in October was $21^{\circ}._{0}$, Oct. 31, 1863.

And now you will want to know what the prospects are for the coming winter. You must ask those who were able to predict, six months ago, a cool summer for the Mississippi valley, and a hot and dry one for the Atlantic States; or who announced a mild winter last year, or a very cold one two years ago. I did not and cannot.

Mr. A. Leonard showed the electrolytic deposition of iron and nickel in metallic form by Klassen's method.

Dr. Engelmann presented specimens of the fruit of the *Cactus triangularis*, from Shaw's garden, and made some remarks on the peculiarities of the plants.

The Secretary presented a paper from G. C. Broadhead on the "Carboniferous Rocks of Eastern Kansas," which was referred to the Publication Committee.

November 20, 1882.

Dr. Geo. Engelmann, President, in the chair. Ten members present.

Mr. Nipher made a few remarks on earth currents and the method of determining their direction.

Wm. J. Sheafer was elected to associate membership.

December 4, 1882.

The President in the chair. Ten members present.

Dr. Engelmann presented specimens of jumping-seeds from La Paz, Baja California. Mr. G. W. Barnes, of San Diego, who forwarded the seeds, says of them,

they are called by the natives "Viuda Favela." The seeds jump out of sight when wet. The leaf of the plant is used by the natives as mucilage. They also use the seeds in extracting sand and dust from the eyes.

The jumping of the seeds was due to the breaking of the pod due to internal strains when wet. and results in the sudden scattering of both seeds and the resulting fragments of the pod.

Dr. Edward Evers presented the Academy with thirty maps of Lower California, made from surveys by the U. S. ship Narragansett.

Mr. Wm. McAdams, of Jerseyville, Ills., exhibited a collection of fossils from the drift of the valleys of the Illinois and Mississippi rivers, and made remarks as follows:

The deposits of the drifts, as seen in digging wells and making other excavations, as well as in the precipitous exposures made by water-courses, consist usually of a reddish-brown clay, underlaid by a bluish plastic clay lying on the surface of the rock, which is usually reached in both Illinois and Missouri at a depth of less than one hundred feet. This depth is, however, sometimes exceeded where the valleys of ancient streams are met with.

Mingled with these drift clays are many boulders and masses of rocks of great interest from the fact that they are often of different material from any rocks we have in place in Illinois. It is quite common to find granite, porphyry, greenstone, and other primary rocks,, that have evidently come from the region of Lake Superior. It is not uncommon to find masses of native copper, doubtless from the same northern locality. The present specimens of this copper are from the drift in the neighborhood of Alton and near Grafton. It is quite probable that a period of many years elapsed —ages, in fact—during the subsidence of the glaciers; and, although it may not be quite certainly ascertained that man beheld the phenomena of this epoch, it is quite certain that many strange animals braved the rigors of the climate and evidently flourished. Some of these animals were of strange appearance, and, where their bones are discovered protruding from the clays, one is astonished at their size. From the clay in the side of a ravine in Calhoun county, Ills., we recovered the jaw of an elephant beside which Jumbo would seem small. One of the teeth from this fossil jaw, and which we present for inspection, weighs nearly eighteen pounds, being much lighter in its fossil state than when in the mouth of the living animal. The teeth of this great glacial elephant are quite different and much larger than the mastodon which also existed during the same period. The teeth of this extinct elephant very much resemble the teeth of the elephant of the present day. We have also taken from the drift clays above Alton the teeth and several bones of a huge carnivorous animal allied to the bison, probably the extinct *Bos latifrous*, the spread of whose horns would make those of a Texas steer seem very small in size.

It is quite probable that during this period more than one species of horse existed. Bones of extinct horses are quite numerous in the tertiary deposits about the base of the Rocky Mountains.

In digging a well in Greene county, Illinois, the workmen found at the bottom of the excavation the teeth of an extinct horse somewhat resembling those of the present day. We also have seen the fossil tooth of a horse from near Alton. All the remains of the horse we have seen from the "drift" are of large animals, while the majority of the fossil horses from the "bad lands" of Dakota are quite small.

Along the banks of the Mississippi the character of the "drift" deposits is somewhat changed by a sort of lacustrine marly clay left during the slow subsidence of the waters down the river valley after the ice had melted away. This marly clay deposit which caps the river bluffs is called loess, and passes gradually into the drift clays below. It is somewhat remarkable that with the many fluvatile shells and remains of land animals in the loess we also occasionally find the remains of animals almost wholely marine. From the loess above Alton, a few years ago, was recovered the skull of a species of walrus, with curved tusks down from the upper jaw, and much resembling the walrus now inhabiting the Arctic seas. From the clays over the quarries at the mouth of the Illinois river we have taken the remains of a large and undescribed animal that had apparently curved tusks depending from the upper jaw not unlike the walrus. These tusks were some three feet in length, the smooth surface of the ivory being raised longitudinally in fluted parallel lines, quite unlike the tusk of any known animal. We present portions of these tusks for inspection. Both in the true and modified drift we have seen the remains of rodents, some of them small; but one, an extinct beaver, was of monstrous size. Some of these animals, from the fact that their remains have been found in the mire of swamps, survived the drift period and became extinct in later periods. This is especially true of the mastodon. As little as is known of the animals of this period, still less is known of the vegetation. We also present specimens of wood from the same horizon.

At one locality on Otter creek, in Jersey county, Ills., the stream cutting through an ancient valley filled with drift clays, there is exposed beneath the drift clays a preglacial soil nearly four feet in thickness. In this curious deposit wood and other vegetation are numerous. A tree lies prone in this soil with parts of the limbs still attached. The trunk of the tree, of which we present a section with portions of the limbs adhering, is flattened and almost turned to lignite by pressure and lapse of time. But what is still more interesting are the cones or fruit which the tree bore. These cones are about an inch in length and somewhat resemble those of a species of conifer, different, however from any known species. We place before you other remains of this ancient vegetation.

Dr. Engelmann remarked that he had formerly found near St. Louis a fragment of tooth similar to the walrus tooth exhibited, but it had been lost in the fire which destroyed the museum of the Academy.

December 18, 1882.

The President in the chair. Seven members present.

Dr. Engelmann said that the jumping-seeds presented at the previous meeting were *Ruellia tuberosa*, growing in dry countries. The pods open when wet, and when the conditions for successful germination are most favorable. The plants are common in Texas, Mexico, and the West Indies. The seed is mucilaginous like the flax-seed, but he did not find the leaves to be so. He also remarked that allied species are found here, around St. Louis, although the seed-pods of our species have not been observed to have the properties of *tuberosa*.

Dr. Engelmann also reported that the cones found by Mr. McAdams in the drift clays of Jersey Co., Ills., and shown at the last meeting, seem to belong to the white-spruce, a tree now found in northern Michigan and Wisconsin, around Lake Superior.

January 2, 1883.

The President in the chair. Nine members present.

George W. Lettermann presented the Academy with trunk sections of the following varieties of wood: ***Diospyros Texano***, Austin, Texas; common persimmon, Allenton, Mo.; ***Juglans rupestris***, Baird, Tex.; ***Cratægus brevispina***, Wood Co., Tex.; ***Morus microphylla***, Baird, Tex.; ***Ungnadia speciosa***, Dallas, Tex.; ***Forestiera pubescens***, Baird, Tex.; ***Rhus aromatica*** (triloba), Baird, Tex.

Mr. Nipher exhibited a working set of duplex telegraph instruments and explained their action.

The President then read his annual address, as follows:

THE PRESIDENT'S ADDRESS.

Gentlemen of the Academy:

It behooves me to give you an account of the past year's history of our Institution. This history, however, is a rather quiet one. We feel now fully at home in our comfortable quarters in Washington University, where we find ample room, surrounded by our rapidly increasing library and by the rudiments of our museum. We have met here regularly, reading and discussing papers, and examining objects of scientific interest presented to the Academy, and are always happy to show our hospitality to our friends and to those of Science. While all around us the activity in scientific work and especially in the Natural Sciences is increasing, and is making itself felt in investigations and discoveries as well as in the practical application of these, we work along in our unpretentious way, convinced that every honest laborer in this vast field adds to the general fund of knowledge.

As a result of our scientific work we were able to publish last spring another number of our Transactions, No. 2 of vol. iv., and it is expected that a third number can be issued in the course of this year, as it is already fairly under way. This, however, makes it so much more necessary that our means should be realized, for I cannot too earnestly urge upon the members of this Academy that through our publications not only our relations with other societies and other men of science are kept up, but through them our standing as a scientific body must be sustained. And these publications cost money; they are, in fact, the greatest expense we have; most of our means go to pay the printer and engraver.

We have now an exchange list of 314 names, scientific bodies and men of science spread over the whole globe, to whom we send our Transactions and from whom we receive their publications, generally much more extensive than our own. Nine names, six of them in foreign countries, have been added in the past year. Through our Transactions the name of St. Louis as a scientific centre is thus carried to all parts of our globe. Our exchanges are accomplished partly through the mails, but those with foreign countries, as heretofore, almost entirely through the agency of the Smithsonian Institution, which, as you know, is gratuitous, cexept as to the freight between here and Washington.

In carrying on these exchanges we have had the invaluable service of our Corresponding Secretary, whose good work we now appreciate so much the more as we are going to lose him. For nearly twenty-five years and almost since the foundation of this Academy he has, with the exception of a few years when he was absent from the city, conducted the affairs of his department with such great zeal and punctuality that it will be difficult to find him a worthy successor.

From the report of the Treasurer, it appears that during the past year $736 have been collected, of which $461 came from regular dues of members and $275 from voluntary subscriptions to the publication fund. His expenses amounted to $923.27, principally for printing and engraving, and partly for fitting up our hall and library, and for other minor expenses.

The year 1881 having left us minus $97.13, the deficit in the treasury now is swelled to $284.50, besides which we owe for printing and engraving $150.75—together a debt of $435.25—against which the Treasurer has unpaid accounts against members of $712. which it is earnestly desired should be paid in; and thus the pressing difficulty of the Academy can at once be relieved.

The number of our associate members at this date is 101, three of which are life-members. Twelve names have been added to the list during the past year; one member has resigned and two have left the city.

Having thus laid before you the present condition of our Academy, I hope to have shown you that our Institution is firmly established as a central point of Science in the Missisippi valley; and, with our faithful work and the favor of our St. Louis friends—and thus, I hope, we can designate our entire population—we can cheerfully look into the future.

The officers for the ensuing year were then elected, the result being as follows:

President—George Engelmann.
First Vice President—James M. Leete.
Second Vice President—Melvin M. Gray.
Corresponding Secretary—Henry S. Pritchett.
Recording Secretary—Francis E. Nipher.
Treasurer—Enno Sander.
Librarian—Gustavus Hambach.
Curators—Gustavus Hambach, Edward Evers, Charles Ludeking.

January 15, 1883.

Dr. J. M. Leete in the chair. Six members present.

Mr. Nipher gave a lecture on the mathematical theory of potential, illustrating his remarks by plaster models of potential surfaces.

February 5, 1883.

Dr. Engelmann in the chair. Eight members present.

Mr. Nipher presented a verbal communication on vortex motion.

February 19, 1883.

M. L. Gray in the chair. Seven members present.

D. S. Brown presented a section of the trunk of a screw-pine.

Mr. Nipher presented a model representing the thermodynamic surface of steam, showing the relation between volume, pressure, and temperature. The scale of the model was not large enough to show the departure of the superheated steam from the condition of a perfect gas. The steam line was shown so far as its coördinates are known, and the surface for superheated steam was represented by two sets of threads parallel to the two rectilinear directrices. The condensation surface was also shown by threads representing isothermal lines, which are also lines of equal pressure, stretched between the steam line and the plane of pressure-temperature.

March 5, 1883.

M. L. Gray in the chair. Five members present.

Mr. N. Holmes made a few remarks on the properties of the æther.

March 19, 1883.

J. M. Leete in the chair. Eight members present.

A paper was read by G. Hambach entitled "A Description of New Species of Paleozoic Fossils," with plates. The paper was referred to the Publication Committee.

April 6, 1883.

A. Todd in the chair. Six members present.

The meeting was devoted to business.

April 20, 1883.

Dr. Engelmann in the chair. Eight members present.

Mr. Nipher exhibited a plaster model representing the surface whose equation is

$$y = x \quad ,$$

and made some remarks on the properties of the surface.

May 7, 1883.

Dr. J. M. Leete in the chair. Nine members present.

Mr. Nipher read a paper on the "Evolution of the American Trotting-Horse," which was referred to the Publication Committee.

He also exhibited a map of New Madrid County, Mo., which showed the present location of all swamp land in the county, and also showed the location of the Spanish land grants made prior to the earthquake of 1811.

It was apparent at a glance that the Spanish grants are all on the dry land of the present day, and it is beyond all dispute that these grants cover precisely the land which one would now select as most desirable. The map was sent by Mr. A. O. Allen, of New Madrid, who first called attention to this fact as furnishing conclusive proof that no material or general change of level occurred during that earthquake.

Mr. Nipher also remarked that

the position of the trees in the swamps of that region showed no evidence of any general sinking of the surface. The swamps were covered with heavy timber which antedated this earthquake, and the trees were as erect and regular as in any swamp. Earthquakes occur in that region every few years, and the grossly exaggerated stories of this earthquake certainly had some foundation in fact, but the highly colored accounts of the immense damage were doubtless connected with the legislation of Congress for the relief of the alleged victims of the alleged disaster.

May 21, 1883.

Dr. Engelmann in the chair. Nine members present.

Dr. Engelmann referred to the cool weather at the present time as follows:

Late cool days in May have occurred

May	2, 1851	29°
"	7, 1867	35°
"	11, 1864	39°
"	22, 1838	40°

After May 2d the temperature has not fallen below freezing since my observations began, and after the 22d the temperature has never before fallen below 40°. To-night, however, the thermometer reads 35°.

Dr. Engelmann presented a paper on the position of conifers in the system of plants. The paper was entitled, "On the Nature of the Female Flower of the Conifers." The paper was referred to the Publication Committee.

June 4, 1883.

Dr. Engelmann in the chair. Six members present.

Dr. Engelmann made a few remarks on the cool weather of the past month. He stated that on the morning of the 22d of May the bottom of the Meramec valley was protected from frost by fogs, and at the top of the bluffs the air was too warm for frost, while on the valley sides there was a belt where frost occurred.

June 18, 1883.

A. Todd in the chair. Eight members present.

Dr. Hambach presented forty-one volumes of reports, for which a vote of thanks was passed.

Mr. Lettermann presented a collection of spear and arrow-points, and also a large implement of unknown use weighing 20 lbs., all found near Allenton.

Baron Ferdinand von Müller and Judge Nathaniel Holmes were elected to corresponding membership.

October 15, 1883.

Dr. Leete in the chair. Six members present.

Mr. Tivy presented specimens of *Myalina* and *Chonetes* from the coal measures at Atchison, Kansas.

Dr. Curtmann presented a copy of his translation of Beilstein's Chemical Analysis, with additions by the translator, which was received with a vote of thanks.

November 5, 1883.

Dr. Engelmann in the chair. Six members present.

Dr. Engelmann presented a specimen of flexible sandstone from North Carolina. He remarked that this stone was also found in Brazil, and is supposed to be the diamond-bearing rock.

Dr. C. A. Todd made a short communication on a subcutaneous pocket found just in front of the ear of a man. The pocket had a depth of a quarter of an inch, and readily admitted a probe. It secreted regularly, the secretion being the same as in the fatty glands. This pocket is always found in a similar position in the Asiatic and African elephants.

Ferdinand Sands, H. A. Wheeler and Dr. Wellington Adams were elected to associate membership.

November 19, 1883.

Dr. Engelmann in the chair. Eight members present.

H. S. Pritchett made a few remarks on the plan of standard time meridians, and exhibited a map issued by one of the railroad companies, on which the time belts of the United States were marked.

He also gave the result of a partial discussion of personal equation in double-star work, and the determination of a system of systematic corrections for different observers with the view of reducing all observations to the same standard.

December 3, 1883.

Dr. Engelmann in the chair. Nine members present.

W. McAdams, of Alton, made a communication on the animals of the loess formations and exhibited several specimens, among others the head of a gigantic beaver.

December 17, 1883.

Dr. Engelmann in the chair. Nine members present.

Dr. Engelmann presented a diagram representing the mean temperature of summer and winter in St. Louis for each year from 1836 to 1883. The work was undertaken with a hope of finding some law for the variation from mean temperature from year to year, but in this he had been disappointed, although it did appear that the variation of the mean temperature of the winters was much greater than the summers. The chart also showed that in every six or seven years the mean temperature returned to near the normal, but this may only be a coincidence.

January 7, 1884,

M. L. Gray in the chair. Nine members present.

The Corresponding Secretary presented a paper by Prof. J. W.

Spencer, of the State University at Columbia, on "New Species of Niagara Fossils," which was referred to a committee consisting of W. B. Potter and G. Hambach.

Mr. Lettermann presented a collection of arrow-points, from near Allenton.

Dr. Adams made a verbal communication on a modified form of telephone which he had constructed for the use of that class of deaf persons in whom the auditory nerve is yet in good condition. The action of the instrument is based on an experiment made by himself, that, if the diaphram of the ordinary telephone is removed, and the magnet core be put in contact with the mastoid process of the temporal bone, the message can be distinctly heard when the ear is closed. A deaf person who cannot hear in the ordinary manner, can also hear in the same way if the auditory nerve is in sound condition. The same result follows if the diaphram of the telephone is put in contact with the temporal bone.

The address of the President, Dr. Engelmann, was deferred by reason of sickness.

The election of officers for 1884 then took place, with result as follows:

For President—George Engelmann.
First Vice President—James M. Leete.
Second Vice President—M. L. Gray.
Corresponding Secretary—H. S. Pritchett.
Recording Secretary—Francis E. Nipher.
Treasurer—E. Sander.
Librarian—G. Hambach.
Curators, { G. Hambach, E. Evers, Chas. Ludeking.

January 21, 1884.

Dr. J. M. Leete in the chair. Six members present.

The committee to whom was referred the paper of J. W. Spencer, on "New Species of Niagara Fossils," reported favorably on the same, and it was referred to the Publication Committee.

February 4, 1884.

Dr. Leete, Vice President, in the chair. Six members present.

After the reading of the minutes, Dr. Briggs made the announcement that he had received from Dr. G. J. Engelmann a communication announcing the death of his father, Dr. George Engelmann, who died at 5:30 o'clock P.M. to day.

On motion, the Academy adjourned as a tribute of respect to the memory of its dead President.

February 18, 1884.

M. L. Gray in the chair. Seven members present.

Mr. Nipher showed the reversibility of the Töppler-Holtz machine, and showed that it would run well as a motor without the diagonal rod and collecting brushes, under which conditions it would be inoperative as a generator.

Mr. A. Todd offered the following resolution:

"*Resolved*, That by the death of Dr. George Engelmann this Academy has lost its chief founder, its ablest instructor and contributor, its most distinguished representative in the scientific world, and the sciences have been bereft of one of their most devoted disciples, useful explorers, cautious and systematic publishers, and intelligent demonstrators."

Upon this resolution Mr. M. L. Gray made the following remarks:

Mr. Chairman and Members of the
Academy of Science of St. Louis—

I have been requested to present a brief memorial to the memory and virtue of our lately deceased associate and President, Dr. George Engelmann. Distrusting my ability to adequately perform this duty, I am, nevertheless, glad to express my admiration of his talents, culture. and attainments — my respect for his character and love for all his noble qualities of head and heart. The time and occasion will not permit of a full review of the whole of his life and life-work—that fittingly belongs to other and better hands—and I shall therefore confine myself more especially to his career and services, as connected with our Academy, to those phases of his character that we all have witnessed and appreciated as from time to time, during many years, he has come in and gone out before us, and dropped those words of wisdom and instruction that have, I trust, made us wiser and better from our associations with him.

The founders of beneficent institutions are in every civilized society justly held in high esteem and honor. The founders themselves soon perish and pass away, but the institution lives on, and, if its object be to enlighten, educate and elevate its members, or the people, it scatters its blessings long after the projectors have ceased their labors; and yet in such cases it remains true that all the subsequent benefits of the institution are the result and fruitage of the planting and labors of the original founders. Dr. Engelmann was not only one of the founders of this Instiution, but, as an examination of its records and proceedings will show, he was one of the most active and prominent, and if in the future it shall achieve in the way of scientific research and discovery more than it has done in the past it may well be attributed, at least in part, to his sagacity and foresight.

He helped to organize the Academy of Science of St. Louis on the 10th of March, 1856, and was chosen its first President; and the charter granted by the Legislature of our State on the 17th of January, 1857, was accepted on the 9th of February of the same year. There were other men of great ability and scientific attainments associated with Dr. Engelmann in the formation of this Academy, several of whom are still living; and of those dead I may mention Drs. Hiram A. Prout, Benj. F. Shumard, M. M. Pallen, Charles A. Pope, and M. L. Linton, upon the graves of each of whom, well known to us, I would place a flower—a forget-me-not—while speaking of their associate, Dr. Engelmann, more recently deceased.

The published proceedings of the Academy show that from its first representation down to the time of his death Dr. Engelmann was a constant attendant at its meetings, and for the greater part of the time its President and also chairman of the Committee on Library, on Publication, and, for the last twenty-five years, of the Committee on Botany.

The Transactions of the Academy are greatly enriched by articles from his pen, mostly on botanical and meteorological subjects, in which fields of study he took especial delight, and in which, also, he was almost without a peer, especially when we consider that the time he had to devote to these subjects was only the leisure hours snatched from the labors of a large and successful practice of his profession.

How few of us, Mr. Chairman, have ever accomplished, or can hope to accomplish, so much in the intervals of a busy life! All honor to our deceased associate, who has achieved so much and so well in the pauses of an active career!

But not only are the Transactions of our Society enriched with elaborate treatises by Dr. Engelmann on the various subjects that engaged his attention, but especially have our meetings been made interesting and instructive by the oral remarks, explanations and illustrations that have fallen from his lips on the wide range of topics that from time to time have engaged our attention.

It was this aspect of his character that most interested me and that I recall with the greatest pleasure, and shows to my mind not only the richness and universality of his knowledge, but also the precision and logical correctness of his mental operations, and the directness and certainty with which he reached true and just conclusions. No matter how varied were the subjects introduced for consideration and discussion, Dr. Engelmann was always ready and prepared, in a pleasant and unassuming way, to throw additional light on them, and illustrate them by new facts not presented by others; and, if false or unscientific theories or views were presented, his clear insight would at once detect the sophism and expose the sham.

Then, too, on his return from summer trips or other excursions he always came laden with new observations and discoveries gathered from his close study of nature and natural objects, treasured up in memory and imparted with almost boyish pleasure for the edification of the fellow-members of the Academy.

His annual addresses as President are models of their class in clearness and succinctness of statement, and are full of interest, zeal and devotion to the permanent establishment, growth and usefulness of our Institution. In his annual address of January, 1868, he says, "The familiar faces around me, many of them the founders of this Institution, * * * give encourging proof of ever active zeal and of abiding faith in our future"; and further on in the same address, after mentioning the difficulties under which the Society had labored, he adds, "Notwithstanding all these drawbacks and impediments, you have nobly built up and sustained the Academy, and made it what it is to-day—one of the scientific Institutions of our city, and, I may proudly add, of the country."

In his annual address of 1871, speaking of the published Transactions of the Academy, he says, "These publications attracted the attention of the scientific world, and brought us the most liberal exchanges from nearly all the learned societies in America and Europe, and, in fact, the whole civilized world." This good reputation that attached to the publications of this Academy, we know, was owing in great measure to the writings of our deceased associate. This much may be truthfully said without detracting from the merits or learning of other members, who were indeed worthy co-workers with Dr. Engelmann and entitled to high praise. It was their joint labors that achieved so satisfactory a result.

As evidence of the high esteem entertained for Dr. Engelmann by his scientific brethren of America, and of their regard and affection for him as a man, I wish to refer to a matter that came within my own observation. When the American Association for the Advancement of Science held its anniversary in this city a few years ago, it was my good fortune to be present at some of its sessions, and I was struck with the great respect and deference, almost veneration, shown by that body of learned men toward Dr. Engelmann, who then, for the first time, attended upon their deliberations. They seemed to look upon him as their master and teacher, and as one at whose feet they were willing to sit and learn. It was a most touching tribute, spontaneously and worthily paid to one with whose learning and genius they were all familiar, but whom they, as a body, had not before met.

Much in the same way, I am informed, he was regarded by the learned men and scientific societies of Europe. Beyond question, he stood in the foremost rank of the learned men of his time, in the departments of study to which he specially devoted himself, and in his death the scientific world has lost not only a diligent and conscientious student, but we have lost a beloved instructor, companion and friend. The kindly and genial nature, the modest and unassuming manners, the sincerity, simplicity and uprightness of his character and life, made all who knew him his friends. Though he had reached the allotted period of human life, yet scarcely had his eye become dim or his natural force abated, when, in the fullness of years, he was gathered to his fathers. It remains for us to cherish his memory, be stimulated by his virtues, and profit by his example. As the pines, the firs, and the flowers, whose habits he studied and so lovingly described, send forth their fragrance upon the air to give pleasure and health to those who inhale it, so may the aroma and sweetness of his life and character stimulate us to better living and doing.

Mr. Nipher made additional remarks, as follows:

Dr. George Engelmann, for many years the honored President of this Academy, died February 4th, aged 75 years. Dr. Engelmann's earliest publications were made in 1832, and consisted of two small volumes. In 1837 he made extended tours through Missouri, Arkansas, Kansas, Indian Territory, and New Mexico. At this time he also began his temperature and rainfall record, which, with the exception of a few gaps when absent from the city, he continued down to within a few days of his death. His last report, on the meteorology of January, was made out after all hope of life had been abandoned by his physicians.

In 1843 he accompanied the party which made the survey of the Mexican boundary, and this field work occupied him two years. The results of his investigations were published in a large work by the Government in a report entitled, "A Description of the *Cactacea* of the Boundary," with seventy-six plates.

Then for several years an extensive practice in his profession absorbed the greater part of his time, but his interest in scientific work did not flag. In 1842 he had already published a paper, illustrated by a plate, in volume xliii. (1842) of Silliman's Journal, on the genus *Cuscuta*, which attracted general attention, and was republished in Hooker's Journal of Botany, 2d volume, 1843. He continued his investigations in this genus, and finally published in our Transactions an elaborate paper entitled "Systemic Arrangement of the Species of the Genus *Cuscuta*, with Critical Remarks on Old Species and Descriptions of New Ones." The materials for this paper were drawn from various expeditions in the West, and from many American collections, in addition to the vast material placed at his disposal by the directors of the great collections in London, Paris, Berlin, Vienna, and Geneva.

Other important papers were: "Additions to the Cactus Flora of the United States"; "On *Pinus aristata* and other Rocky Mountain Pines"; "A Revision of the North American Species of the Genus *Juncus*, with Descriptions of New or imperfectly known Species"; "Notes on the Genus *Yucca*"; "Notes on *Agave*"; "On the Oaks of the United States"; "The

American Junipers of the Section *Sabina*"; "A Synopsis of the American Firs"; "Revision of the Genus *Pinus*"; "The Genus *Isoëtes* in North America"; "Mean and Extreme Daily Temperature at St. Louis during Forty-seven Years."

In all about thirty-two papers appear in the Transactions or Proceedings in addition to his current comments upon the climatic peculiarities as compared with that of former years. In addition, he was a constant contributor to various botanical journals. His last paper was perhaps not completed as he desired. Concerning it he wrote only three days before his death, "My botanical paper not ready yet;—soon."

Dr. Engelmann was a true type of scientific man. He labored solely to advance the boundary of knowledge, and without any reference to the pecuniary value of the results reached. Sometimes his knowledge was of immense financial value, as when his advice was sought by the agents of the French Government regarding the use of native American grapes as grafting-stock for French vineyards. But this was not the motive which prompted his work; had it been so, it could not have been done so thoroughly and well. I need not say that his aim was to do his part in the solution of the great problems which interest us all, and that his reward was the noble joy which attends the discovery of truth.

His fame is not an affair of newspapers and of to-day. The plants he introduced to his brother botanists will come forth each year, many of them bearing the names he gave them, and will introduce him in turn to each succeeding generation of men. He sleeps well; and his beloved oaks, standing like sentries around his new-made grave, join in solemn chanting and give gentle voicing to the sorrow which fills all our hearts.

The resolution of Mr. Todd was ordered to be entered upon the minutes.

Dr. G. J. Engelmann presented two charts of mean daily temperature at Chiswick and Greenwich, and called attention to the irregularities in the curves, showing that even in that more uniform climate it would take many years of additional observation to obtain uniformity.

March 3, 1884.

Dr. Leete in the chair. Six members present.

Mr. Nipher exhibited Hellmann's temperature diagrams for twenty-five cities of North Germany, giving pentad means for thirty-five years. Attention was called to the fact that the fluctuations in the curves were common to the curves for all cities.

Mr. A. Hunicke was elected to associate membership.

March 17, 1884.

Mr. W. H. Tivy in the chair. Seven members present.

A letter was read from Prof. J. W. Spencer with acknowledgment of his election to corresponding membership.

Mr. Nipher read a paper on the "Measurement of Electrical Resistance as a Velocity," which was referred to the Publication Committee.

April 7, 1884.

Dr. J. M. Leete in the chair. Present—Messrs. Leete, Tivy, Wheeler, Hambach, C. A. Todd, A. Todd, Holmes, Speck, Smith, Nipher, and Collet. Minutes of previous meeting read and approved.

The Engineers' Society of Urbana, Ohio, was placed on the exchange list, to begin with vol. iv.

Mr. H. A. Wheeler made a communication on the formation of natural coke from lignitic coal in Pleasant Valley, Utah.

Adjourned.

April 21, 1884.

Dr. C. A. Todd in the chair. Present — Dr. C. A. Todd, Wheeler, and Nipher.

Mr. Nipher exhibited a large Wheatstone's bridge, and showed themanner of using it in measuring resistance.

Adjourned.

May 5, 1884.

Dr. Leete in the chair. Present—Messrs. Leete, Pritchett, Potter, C. A. Todd, Ives, Tivy, Engler, Gray, Briggs, Luedeking, Wheeler, Adams, Sander, Speck, A. Todd, Hambach, and Nipher. Minutes read and approved.

Mr. Todd, chairman of the committee to secure the portrait of Dr. George Engelmann, made the report that the portrait had been secured, and he presented the portrait to the Academy, with a few appropriate remarks.

Mr. Nipher made additional remarks as follows:

It is with mingled feelings of pain and pleasure that we assemble here to-night. The occasion reminds us of one who formerly bore his part with us, and who labored long and earnestly to promote the interests of science in our midst. But with our sorrow at the loss of so noble a companion, comes also the feeling that the cause for which he labored is not lost. The workmen perish, but the work goes on. The cause of science is now so firmly fixed in the minds and hearts of its promoters, the methods and results of scientific work have come to form so essential a part of our modern intellectual life, and the material comforts and prosperity of society are now seen to be so directly involved in the progress of scientific discovery, that a failure of the cause is no longer possible. It is only possible that here and there the cause may languish for a time—that eddies may form in the stream, which, however, as a whole, moves always onward.

It is sometimes forgotten that the discovery of new truths is not of itself a remunerative occupation. The engineer who makes use of the knowledge which has been gained — and gained mainly by his predecessors — in the construction of public works, and useful machinery, can make a direct demand upon the public which he directly serves. His service is sought. The results of his work are plainly presented to the public eye, and in such a manner that they are at once recognized as being of value to the public. His elder brother, the scientific investigator, is sometimes at a greater disadvantage. His service to the public is an indirect one. It is not in general sought, and, when the service is rendered, its value is not, as a rule, fully understood even by himself. In 1830, Faraday discovered induced or secondary electric currents. At that time the value of the discovery was generally conceded by his brother philosophers, and it marked a great advance in our knowledge of the subject. But it is only within the last eight or ten years that this discovery has become of enormous value to the public through the telephone and our electric-lighting systems, and there can be no doubt that the near future will see a similar development of the plan for the electrical distribution of power. All of these interests originated in this one discovery of Faraday. Now, it was not possible to properly reward Faraday for this immense service, because at that time, or while he lived, its value was not known; it is not even yet known. It is not, therefore, feasible to place any definite value upon the work of a scientific investigator; but the lesson which we do learn is, that some provision ought to be made which will permit this kind of work to go on. Some provision ought to be made which will enable those who devote their lives to science, to live as comfortably as those who serve the public as salesmen, railway managers, or bank presidents. In addition, a scientific investigator should have the necessary books and apparatus for his work, and he should have the companionship of men who like him have devoted their lives to the service of science. Unless these conditions are supplied, the work is always done at a very great disadvantage. The conditions here insisted upon as necessary, are provided for reasonably well in a properly equipped university in addition to those offered by a properly equipped academy of science. The aims of the university and the academy of science are identical. Both aim to foster investigation and to advance knowledge, and to diffuse this knowledge among men. The academy, however, occupies itself more particularly with what is new, and thus the two institutions supplement each other. Nor need we fear that all the work has been done by the worthies that have preceded us. Notwithstanding the splendid achievements of the past, the academy of science has yet a boundless untrodden field before it. Like the four sages of whom Dante gives us a beautiful picture, we stand in the hemisphere of light which has been kindled in our midst, and which gradually beats back the surrounding darkness; but this only serves to reveal to us the immensity of the region of darkness which still lies beyond. The work so far done is hardly a beginning, compared with what remains undone. Even if it were true that the main features of the field of science had been explored, so that the work yet to be done consisted merely in the filling in of intermediate details, this work alone would be too vast for completion within the lifetime of humanity.

It was once recommended that a systematic examination of all alloys of metals be made, beginning with binary ones, and then proceeding to ternary and quaternary ones. If we take the number of available metals at 30, the number of binary alloys possible would be 435, and this without regarding the proportions of the metals, but regarding only the kind of metal. To examine these alloys as to hardness, tenacity, elasticity, conducting and radiating power, thermal capacity, frictional properties, etc., varying the proportions of the metals say by one per cent., would probably require at the very least ten thousand years of work. The number of ternary alloys possible without regard to proportion is 4,060, and by varying the proportions by one per cent. the number increases to over eleven millions. Prof. Thurston has made a partial examination as regards the tenacity of the zinc-copper-tin alloy, and has shown that, in order to gain a complete knowledge of its behavior, it is necessary to vary the proportions by very small amounts. Now it is hardly necessary to say that if all the scientists on the earth should give their attention to the examination of metallic alloys for the next twenty thousand years, the knowledge gained on this subject would be merely fragmentary; and it hardly admits of doubt that many of these alloys would turn out to be of great value for special uses.

If we come now to chemical compounds, the number of possible substances becomes too vast for human comprehension. The city of St. Louis does not contain houses enough to hold the books which would contain only the names of the compounds which it is possible to form from the known elements; and how many of these compounds like aniline, or chloroform, or nitro-glycerine, may prove to be of the greatest value when they come to be studied?

When we come to physical and mechanical combinations, the same thing is true. Long before the time of Faraday, all of the mechanical elements of the telephone and the dynamo machine were known, and in 1830 the electrical principles involved were known. The mechanical skill necessary to produce these machines was not wanting. It was simply necessary to know what was wanted, and then to discover the proper combinations for the mechanical elements.

The experience of the last century shows that it pays society to have scientific work done. The dividends are not declared at once, and although the benefits arising from scientific work may not be realized at once, they are sure to come sometime. The support of scientific work is to be undertaken with the same feeling that prompts the founding of schools, or any of the other public projects which are undertaken by public-spirited men in a civilized community.

In a large city like St. Louis, it is of the utmost importance that great institutions of learning should be built up and fostered. Just as our merchants should provide themselves with all that is needed in order to satisfy the material wants of the people of the tributary country, so our learned institutions should be placed upon such a footing, that the intellectual needs of the people can also be supplied. The St. Louis Academy of Science and the Washington University should be made the great centres of intelligence in the west, to which scholars could come and find the information and aid which they may need. To-night I speak for the Academy of Science. It has already been in existence for over a quarter of a century, and it has published fourteen numbers of the Transactions, costing from five hundred to twelve hundred dollars per number, and costing in all about ten thousand dollars. These publications, of the original work of the members of the Academy, have been paid for by many friends of science who have consented to serve as paying members, contributing the annual dues of six dollars per year, and by voluntary subscriptions when the annual dues were inadequate. Our publications are given to learned societies in every quarter of the civilized world, in exchange for similar publications.

The time has now come when the Academy can be put upon a basis which will insure its permanent success. From present indications the Academy will realize something on the Lucas lot, which will go far towards the purchase of a lot in a more suitable location. As a tribute to the memory of Dr. Engelmann, it would be greatly to the credit of St. Louis if the present occasion could be seized upon as a suitable time to endow the Academy of Science. The Academy owes its very existence to his quiet, unostentatious labors.

A gentleman has made the offer to be one of twenty to subscribe $20,000. In a city like St. Louis, there ought to be no difficulty in finding twenty men who will give a thousand dollars apiece to so noble an object as the one which now engages our attention. I feel confident that it will be done, and that the St. Louis Academy of Science will at once start upon a new career of usefulness.

On motion of Dr. Briggs, the remarks of Mr. Nipher were requested for publication.

The Corresponding Secretary read correspondence.

Adjourned.

May 19, 1884.

Dr. Leete in the chair. Present — Messrs. Leete, Cushman, Sander, Hambach, Nipher, Letterman, Wheeler, Adams, Dr. Evers, and Pritchett.

The Corresponding Secretary read correspondence.

Mr. Nipher described a flash of lightning which took place between a cloud and the clear air around the cloud.

Adjourned.

June 4, 1884.

C. Shaler Smith in the chair. Present—Messrs. Smith, Hambach, Tivy, Evers, Gray, Walker, and Nipher.

Mr. Nipher read a paper on the "Mechanical Efficiency of a Gramme Generator and Motor." The paper was discussed by the members and referred to the Publication Committee.

Adjourned.

June 16, 1884.

Dr. Sander in the chair. Present—Messrs. Sander, Engler, Hambach, Spiegelhalter, Letterman, Wheeler, Pritchett, Gray, and Tivy.

Dr. Spiegelhalter presented a plant from Texas which is known under the common name of "loco" (*Genus Astragalus*), and which has the reputation of poisoning horses and cattle. It is much dreaded by the stockmen. Dr. Spiegelhalter also presented specimens of rocks and plants from Garcer Co., Texas, covered with a deposit of salt.

A number of arrowheads found near Allenton, Mo., were presented by Mr. Letterman.

The following resolution was introduced by Mr. Pritchett and unanimously adopted:

Resolved, That, in the opinion of the Academy of Science of St. Louis, the bill now before Congress which contemplates the dismemberment of the Coast and Geodetic Survey and the delegation of its work to the Navy Department and the U. S. Geological Survey, would, if passed, prove fatal to the scientific work of the Navy, and in the end would prove more costly to the Government.

Resolved, That a copy of this resolution be sent to the representatives of Missouri both in the Senate and House, and they be requested to use their influence in the defeat of the bill.

On motion, the Academy adjourned until the third Monday in October, 1884.

October 6, 1884.

Dr. J. M. Leete, Vice President, in the chair. Present—Messrs. Leete, Engler, Luedeking, C. A. Todd, Nipher, Pollak, Tivy, and Speck.

Minutes of last meeting were read and approved.

Mr. Nipher read a paper on "The Relation between the Violence and Duration of Maximum Rains."

Adjourned.

October 20, 1884.

Dr. J. M. Leete, Vice President, in the chair. Present—Messrs. Leete, Sander, Engler, Hambach, Tivy, Potter, Wheeler, Pritchett, and Dr. Todd.

Voted to place the Naturhistorische Verein of Hamburg on the exchange list, to begin with vol. iv.

Dr. Todd presented specimens of Frontenac limestone at Lake Pepin. Mr. Tivy presented chips made by the beaver.

Mr. Potter showed specimens of bat guano and clays from caves in Laclede county, Mo., and was requested to furnish a paper for publication.

Mr. Allderdice was elected to associate membership.

Mr. Nipher's paper of the previous meeting was referred to the Publication Committee.

Adjourned.

November 3, 1884.

Dr. Leete, Vice President, in the chair. Present—Messrs, Leete, Pritchett, Hambach, Wheeler, Tivy, Dr. Todd, Sander, Dr. Adams, Dr. Spiegelhalter, Nipher, and Engler.

Moved to put the Journal of Microscopy and Natural Science, London, on the exchange list, to begin with vol. iv.

Dr. Hambach read a paper on "New Fossils in the Green River Region of Wyoming." Referred to the Publication Committee.

Adjourned.

November 17, 1884.

Dr. Leete, Vice President, in the chair. Present—Messrs. Leete, Hambach, Sander, Allderdice, Nipher, and Dr. Adams.

Mr. Nipher gave some account of a new ergometer for measuring the power required to drive a Holtz machine. He also gave an account of an examination of his rain-gauge by Boernstein as given in the Meteorological Society of Berlin.

Rob't Moore and M. L. Holman were elected to associate membership.

Adjourned.

December 1, 1884.

Dr. Leete, Vice President, in the chair. Present—Messrs. Leete, Hambach, Engler, Tivy, and Nipher.

Minutes of the last meeting read and approved.

On motion of Mr. Nipher, it was resolved to appoint a committee to draw up a memorial to Congress, petitioning for the removal of the duty on scientific books and apparatus. The chair appointed Messrs. Nipher, Engler, and Hambach.

Messrs. D. C. Humphreys and Pope Yeatman were elected to associate membership, and Dr. G. Von Rath of Bonn was elected to corresponding membership.

Adjourned.

December 15, 1884.

Dr. J. M. Leete, Vice President, in the chair. Present—Messrs. Tivy, Hambach, Moore, Gray, Leete, Sander, Speck, Engler, and Nipher.

Minutes of previous meeting read and approved.

Dr. Hambach read a paper on "Some New Palæozoic Fossils," which was referred to the Publication Committee.

Mr. Engler reported for the committee appointed to draw up a memorial to Congress, petitioning for the removal of the duty on foreign scientific books and apparatus. The report was adopted, and the Recording Secretary was instructed to send a copy to Senator Cockerell and Representative Broadhead.

On motion of Dr. Hambach, it was voted to complete the set of the Transactions sent to the Natural History Society of Glasgow.

Adjourned.

January 5, 1885.

Dr. J. M. Leete, Vice President, in the chair. Present—Messrs. Leete, Potter, Engler, Moore, Wheeler, Evers, Hambach, Luedeking, Allderdice, Tivy, Spiegelhalter, Sander, Letterman, and Nipher.

Minutes of previous meeting read and approved.

The Corresponding Secretary was absent by reason of illness.

Dr. Leete made the following remarks on the work of the Academy during the past year:

Gentlemen of the Academy,—

It is fortunate for me that the Academy has no established rule to be observed by the Chairman at its annual meeting. It will then not be expected that I will attempt to set out even in general terms what has been accomplished in the great domain of Science during the year just closed. It will not even be expected that I will attempt to lay before you at this time what our Academy has done during the year 1884.

If there were strangers present, it would be proper to say that our Society embraces two classes. The one, and the smaller, is made of such as pursuing their chosen lines of investigation do the work that is done by the Academy; in the other, and much the larger class, will be found those who are lookers-on, and are entertained and instructed by the workers.

It has not been customary to declare at the close of a year just what or how much has been accomplished during a twelve-month; but when sufficient material has been collected to make a respectable volume, and there is sufficient money in the treasury for the purpose, the Transactions of the Academy have been published.

During the past year our Academy has sustained a very great loss. Our highly honored and much loved President. Dr. George Engelmann, passed away early in February, 1884. His life had been one of great activity and usefulness, and he had lived much beyond the limit ordinarily allotted to men. His preparation for the duties of his profession had been so full and complete, and he discharged those duties so faithfully and so acceptably, that it may with great propriety be said that he adorned the profession of Medicine. I think it may be said without injustice to anyone that to Dr. George Engelmann more than to any other one person our Academy is indebted for the reputation it enjoys. He was closely identified with it for a long period, and was its honored President during many years. He was, in truth, the strong pillar on which the Academy rested. Whatever time he could spare from the duties of his profession, he constantly devoted to research in the fields of his choice. And all his work was done with such painstaking care and thoroughness, that, when he published his results, this Academy knew, and all the scientific world knew, that a permanent addition had been made to the fund of useful knowledge. Although he has gone, yet, as long as any of us shall meet together here who were wont to meet him in this Academy, he will seem to be present with us. He has gone; but he has left an example of industry and energy in his devotion to scientific research that the Academy may well emulate.

During the year the Academy has exchanged with 252 foreign societies and 72 American, of which 61 sent no exchanges. During the year the publications received have been—books, 285; pamphlets, 172;—total, 457. Of these, 35 were donations and 1 was purchased by the Academy.

The report of the Corresponding Secretary was then read by the Recording Secretary:

Mr. President:—I regret that sickness compels my absence this evening from the Academy, and obliges me to send a somewhat incomplete report.

The number of publications received during the year has been large, and our own exchange list has been considerably increased. No. 3 of vol. iv. was issued and mailed to exchanges in July. The receipts and expenditures made are given in detail on a separate sheet. The total receipts have been \$29.50 and the total expenditures \$21.22, leaving a balance of \$8 28 to be turned over to the Secretary to be elected to-night.

My studies are so pressing, and of such a nature, that I find it impossible to give to the work of Corresponding Secretary the time and attention it should have. In addition, my work at night at the observatory compels me to be absent often when the Corresponding Secretary is needed. On this account it will be impossible for me to assume the duties for another year.

The Treasurer then read the following report:

The Academy of Science has, according to the books, 91 active members, of whom 6 have been elected during the preceding year. Four members have resigned, two have been dropped for non-payment of dues, one left the city and is now living in Europe, and one—our most cherished President of many years, and the most shining light of all the western scientists—has been lost to us forever, to the deeply felt regret of all our active members.

During the last year $565.35 has been collected for dues and on special resolutions, and it is much to be regretted that some members have failed to answer to the summons of the resolution of the Academy for the contribution of one dollar only to the memory of our beloved late President. The portrait of the President has been secured at the low figure of $100, framed very becomingly in a rich gilt frame, the gift of Professor E. A. Engler.

The expenditures of the Academy amounted to $602.31: of this sum. $460.41 was paid for the balance on printing the last number of the Transactions, issued in June last; $38.90 for the use of the library and attendance to the rooms of the Academy; $28.00 for defraying the expenses of the Recording and Corresponding Secretaries, and $75.00 for the portrait of Dr. Engelmann.

It is to regretted that the balance against the Academy, which amounted to $137.62, has not been decreased, but has been raised to $174.37—which is, however, almost $150.00 less than in 1883. From this statement you will see that the habit of some of the members not to comply readily with the demands of the Treasurer is much to be regretted. There is $597.00 due the Academy at present, of which sum there is, perhaps, one-fourth difficult to be collected, although due from members who have requested to be kept on the rolls, and who have promised ultimately to pay.

Trusting that next year the members of the Academy will rally, and will attend more punctually to their duties to the Treasurer, that we may be able to publish another number of our Transactions without requesting voluntary contributions from our members, I submit the foregoing report most respectfully.

ENNO SANDER, *Treasurer.*

On motion, the report and papers of the Treasurer were submitted to the examination of a committee consisting of Messrs. Tivy, Potter, and Engler, who reported the same to be correct.

Mr. Letterman, of Allenton, exhibited specimens of the "loco" from Texas and Kansas (Bot., *Astragalus mallissimus*). He said that experiments by Dr. Ott had shown that this plant was poisonous to horses and cattle, and it has given much trouble to stockmen in Kansas and Colorado. The State of Colorado pays $30 a ton for the destruction of the plant. This law has had the result of inducing persons to raise the plant.

Mr. Wheeler exhibited a mineral, formerly rare but now more common, but still much sought after as an ornamental stone. The mineral is called tiger's-eye, and is found in Africa. It is a silicate of iron, and is a pseudomorph after crysidolite.

On motion of Mr. Tivy, the election of officers for the ensuing year then took place, resulting as follows:

President—Francis E. Nipher.
First Vice President—James M. Leete.
Second Vice President—Melvin L. Gray.
Corresponding Secretary—E. Evers.
Recording Secretary—Edmund A. Engler.
Treasurer—Enno Sander.
Librarian—Gustavus Hambach.
Curators—Gustavus Hambach, W. H. Allderdice, Charles Luedeking.

The Academy then adjourned.

January 19, 1885.

The Academy met Monday evening, Jan. 19, at the Academy rooms. Present - Messrs. Nipher, Sander, C. A. Todd, A. Todd, Wheeler, Hunicke, Tivy, Leete, Potter, Evers, Pritchett, Gray, and Engler.

On motion of Mr. Albert Todd, Prof. Pritchett and Dr. Todd were appointed a committee to escort the newly elected President, Prof. Nipher, to the chairman's seat.

Prof. Pritchett, in introducing Prof. Nipher as the new President of the Academy, referred to the long and faithful services of the President elect in the interests of the Academy, and expressed his pleasure in thus bestowing upon Prof. Nipher a deserved honor in the name of the Academy.

Prof. Nipher, before taking his seat and after gracefully accepting the position to which he had been elected, made some fitting remarks as to the work and future of the Academy.

At the request of the Secretary, the reading of the minutes of the last meeting was deferred to allow time to obtain copies, not yet secured, of reports and addresses then made.

Mr. Albert Todd called attention to the fact that this was the first meeting of the Academy since the death of Prof. Benjamin Silliman, Jr., of Yale College, and, upon his motion, the chair appointed Albert Todd, Wm. B. Potter, and H. A. Wheeler, a committee to draft resolutions expressing the sentiments of the Academy and present same at the next meeting.

There being no paper set for the evening, an informal conversation took place upon a variety of scientific subjects which presented themselves: sources of the sun's heat, earthquakes, change of temperature of the earth as centre is approached, wells, cisterns, the waters contained in same, their impurities, need of intelligent supervision and inspection of wells and cisterns in view of the expected approach of cholera in the summer of 1885, and other topics. In the course of the conversation general regret was informally expressed that the artesian well at the Insane Asylum, sunk to a depth of 3,843½ feet, had not been preserved for purposes of temperature (and other) observations.

After the report of the Corresponding Secretary, the Academy adjourned.

February 2, 1885.

The Academy met Monday, Feb. 2, 1885, at the Academy rooms, President Nipher in the chair, and the following members present: Albert Todd, Dr. C. A. Todd, Dr. Evers, Dr. Hambach, Mr. Tivy, Dr. Leete, Mr. Wheeler, Mr. M. L. Gray, Prof. Pritchett, and Mr. Engler.

The minutes of the last meeting were read and approved.

Mr. A. Todd reported for the committee appointed to draft resolutions expressing the sentiments of the Academy on the death of Prof. Benjamin Silliman, Jr., the following:

To the Academy of Science.

Your committee appointed to report a tribute to the memory of the late Benjamin Silliman, Jr., respectfully submit the following:

By the death of Benjamin Silliman, Jr., occurring on January 14, 1885, the physical sciences have lost a devotee of distinguished and meritorious services for their promotion and usefulness. At his death he filled the chair of Chemistry in Yale College, which his celebrated father had virtually created and made renowned. He proved himself a worthy son of the man who, more than any other scientist of his day, successfully established the study of the sciences of Chemistry, Geology and Mineralogy in our country, and popularized their regard and advancement. For the discovery and publication of Nature's principles in her labors and evolutions in her sublime laboratory of the Universe he was zealous, and for their demonstration in the laboratory of his college for the instruction of her students he was eminently satisfactory, and for their practical application in the grand and useful affairs of the day he was of eminent authority.

The "American Journal of Science and Art," founded by his father in 1818, he coöperated with others in sustaining — a journal that, more than any other, has made known to the world the labors of American scientists and increased their prestige and influence. Its monthly presence to this Society has made the deceased seem to be a monthly visitor, whose final withdrawal will be accompanied by sad regrets and be associated with the mournful farewell of "Nevermore."

Like his father, he enjoyed traveling and visiting the treasures and storehouses of the seats of learning in foreign lands, from which he was fortunate and happy in being able to bring much home for his country's use and enjoyment through instructions in his office, and his clear and ready pen in both scientific journals and popular magazines. In fine, he was one of those rare men whose whole mature life was a fountain of current usefulness to the world of science, and to the public as well, of the most liberal and advanced quality, and of "sweetness and light" in all the social intercourses of life, which he always heartily enjoyed.

Your committee respectfully, with this report, submit the following resolution:

Resolved, That by the death of Benjamin Silliman, Jr., the Sciences have lost one of their most distinguished and meritorious disciples and teachers, and the world of liberal scientific learning one of its most attractive and useful contributors. [Signed,]

ALBERT TODD,
WM. B. POTTER, } *Committee.*
H. A. WHEELER,

On proper motion, the report of the committee was accepted, ordered spread on the minutes of the Academy, and a copy of the resolution sent to the family of the deceased.

The Corresponding Secretary announced the receipt of a new publication, "Journal of Proceedings of the Hamilton Association," 1882–83, which was placed upon the exchange list of the Academy; the Librarian was instructed to send the Transactions, beginning with vol. iv., No. 4.

The following donations to the Academy library from Mr. Engler were duly acknowledged: "La Pluie en Belgique, par A. Lancaster"; "Observations Météorologiques faites par l'Expedition de la Vega du Cap Nord à Yokohama par la Detroit de Behring."

Prof. Nipher gave the Academy a *résumé* of recent researches on Solar heat, basing his remarks upon the work of Prof. Langley, an account of which has just been published in the series of "Professional Papers" of the United States Signal Service.

Adjourned.

February 16, 1885.

The Academy met Monday evening, Feb. 16, 1885, President Nipher in the chair, and Messrs. Nipher, Potter, Wheeler, Alt, Hambach, Allderdice, Briggs, Albert Todd, C. A. Todd, Pritchett, Sander, Evers, and Engler, present.

The minutes of the last meeting were read and approved.

The Corresponding Secretary was directed to comply with the request received from A. I. Appleton for list of publications of the Academy, to be printed in the "American Catalogue of Scientific Publications" now being compiled.

The paper of the evening was by Dr. C. A. Todd, on "The Prevalence of Deafness explained by the Anatomy of the Ear." An informal conversation on the subject presented in the paper followed.

The following gentlemen were elected to membership, as proposed at last meeting: for associate membership—A. B. Chapman, Emerson L. Foote; for corresponding membership—Dr. A. von Danckelman of Berlin.

Adjourned.

March 2, 1885.

The Academy met Monday evening, March 2d, 1885. Present—Messrs. Nipher, Alt, Pritchett, A. Todd, Hambach, Sander, Pollak, Tivy, C. A. Todd, Foote, Speck, Comstock, Green, and visitors.

After the reading and approval of the minutes of the last meeting, Dr. Adolph Alt spoke upon the subject of the evening, "The normal Anatomy of the Human Eye, and the present stand-point concerning Glaucoma."

Mr. Nipher read a report on the winter just passed, in which the comparisons made with other winters are based upon the observations of Dr. G. Engelmann.

The following gentlemen were elected to associate membership, as proposed at last meeting—Heber Livermore, Dr. John H. Jenks; and Theo. S. Case to corresponding membership.

The Academy then adjourned.

March 16, 1885.

The Academy met Monday evening, March 16th, 1885, President Nipher in the chair, and the following members present: Messrs. Walker, Hambach, Leete, Tivy, Wheeler, Moore, Brown, Potter, Gray, Foote, Sander, Allderdice, Pritchett, and Engler.

After the reading and approval of the minutes of the last meeting, Prof. H. S. Pritchett gave an account of the work of the Observatory of Washington University in connection with the U. S. Geological Survey in determining longitudes, in the west and south, which form the basis of a topographical map. A description of the plan of the U. S. Survey was given, the progress of the work to the present time indicated, and the importance of the survey as the basis of geological work explained. Mr. Pritchett said that in Missouri only a commencement had been made, and that at the present time we had no topographical map of the State. In fact we possess a better topographical map of the central portion of the Moon than of the State of Missouri. The time determinations at this observatory had an average probable error of 0.01 sec. on each night.

Mr. Pritchett remarked that preparations were about completed for beginning the work of determining a prime meridian for the Republic of Mexico by telegraphic signals between the Observatory of Washington University and the Observatory of the City of Mexico—a ditsance of 2,000 miles.

Prof. Potter remarked that the question had often been presented whether sewage introduced into the river here would pollute the water; or, in general terms, whether a running stream could purify itself by the oxidation of organic matter which might be thrown into it. There were a few well known chemists, notably Dr. Franklin of London, who were disposed to answer this question in the negative; but the weight of opinion seemed to be in favor of the affirmative view. In support of the latter opinion the testimony of Dr. Miller, of King's College, London, based upon analyses of Thames water taken at various points, was quoted. The question was of especial interest to St. Louis at present, in view of the expected appearance of cholera during the coming summer. To be able to answer the question with reference to the Mississippi river water at this point, Prof. Potter had taken samples of the same body of river water as it passed the water-works, foot of Lesperance st., Carondelet, Quarantine, and Crystal City; and, from analyses of these samples, whose results are given in the accompanying table, it appears that the river water is purer at quarantine than at the water-works, which shows that sewage is absorbed by running water. Doubtless also the mineral matter in suspension, in settling, precipitates more or less of the organic matter. Prof. Potter said there was no danger to be apprehended from sewage thrown into the river at towns above this city.

	Water-works.	Lesperance street.	Carondelet.	Quarantine.	Crystal City.
Total solids	*217.00	295.00	253.00	210.00	215.00
Org. and vol.	67.00	103.00	101.00	65.00	69.00
Chlorine	7.75	17.50	8.00	7.50	7.75
Oxygen, 20 minutes	1.13	1.85	1.25	1.01	1.19
" 4 hours	4.22	4.71	4.60	3.79	4.31
Free ammonia	0.01	1.23	0.01	0.004	0.26
Alb. "	0.065	0.18	0.088	0.055	0.18

* Parts in one million.

Prof. Potter also exhibited the following results of analyses of sewage, samples taken as indicated in the table:

	Av. 10 samples.	Rutger st.	Trudeau st.	Arsenal st.
Total solids	*1306.00	1071.00	1789.00	1310.00
Org. and vol.	45.10	377.00	1165.00	489.00
Chlorine	305.75	278.25	125.25	404.25
Oxygen, 20 minutes	40.66	——	——	——
" 4 hours	71.36	——	——	——
Free ammonia	121.24	——	——	——
Alb. "	1.64	——	——	——

* Parts in one million.

Results were also shown of analyses of Missouri river water, and of Mississippi river water taken above Alton, as follows:

Hydrant. Ap. 19, 1876. Unfiltered.	Grs. per gal.	Jan. 23, 1878. Filtered. Grs. per gal.	Taken above Alton. Grs. per gal.
			Unfiltered 58.32
			Filtered 12.07
Total solids	41.63	Total solids.... 14.17	
Analysis of residue.		Analysis of residue.	Analysis of residue.
Silica	18.17	0.07	0.58
Iron and alumina	8.95	0.06	0.22
Sulphate of lime	2.72	2.84	4.78
Carbonate of lime	3.27	5.02	1.58
Sulphate of magnesia	3.71	2.90	3.12
Water, carbonic acid, and loss	4.84	2.00	1.92
Organic matter, parts per 1,000,000.			
Total organic	38.28	19.14	68.86
Free ammonia.. ...	0.004	0.004	0.026
Albuminoid ammonia	0.15	0.06	0.89

From this table it appears that the Mississippi water contains more organic impurities than the Missouri, and that the Mississippi water contains more sulphates, while the Missouri water contains more carbonates. For this reason the Mississippi water gives much greater difficulty when used for boiler purposes, because the sulphates give more trouble in boiler practice than the carbonates.

Dr. George Richter was elected an associate member.

Adjourned.

April 6, 1885.

The Academy met April 6th, 1885, at the Academy rooms, President Nipher in the chair, and the following members present: Messrs. Leete, Pritchett, Todd, Foote, Curtman, Sander, Tivy, Pollak, Wheeler, Hambach, Walker, Evers, and Engler; also four visitors.

Minutes of last meeting read and corrected.

Dr. Todd exhibited a specimen of the fruit of the Casava plant from Florida.

Prof. Nipher presented a paper on "Two Ergometers," and a paper on "The Efficiency of two Holtz Machines, one acting as Generator and the other as Motor." Both papers were fully illustrated by diagrams. On motion, they were referred to the Committee on Publication.

Mr. Wheeler made some remarks on "A new Blow-pipe Reagent." In the course of some experiments on the use of hydriodic acid, he had found that by the use of tincture of Iodine (suggested by Mr. Luedeking, of Washington University) he was able to get the very striking and characteristic reactions on the iodides of the volatile metals with the alcoholic solution of the iodine.

Mr. Wheeler was asked to reduce his remarks to writing, and same were referred to Publication Committee.

Dr. Curtman called the attention of the Academy to the groups ot littte black spots to be found on the peels of apples. Examination with the microscope had shown them to be colonies of fungi, uniformly distributed over the surface, and wholly external to the apple. A great number and variety of apples had been examined and these colonies of fungi had been found on all—as often on one part of the apple as on another—and the individual spots from ⅛ inch to ¼ inch apart. It was not apparent that they were at all injurious to the fruit. Dr. Curtman expects to give the matter further attention in the future.

The following gentlemen were elected to associate membership: Eliot C. Jewett, Dr. W. Hoffman, George M. Bartlett.

Academy adjourned.

April 20, 1885.

The Academy met Monday evening, April 20, 1885. President Nipher in the chair, and Messrs. Leete, Tivy, Wheeler, Gray, Evers, and Engler, present.

The minutes of the last meeting were read and approved.

Mr. H. A. Wheeler made some remarks on temperature observations in deep mines.

The result of his observations in the deep copper mines in the Keweenawan rocks of lake Superior indicated probably the lowest rate of thermal increase with descent into the earth that has been recorded. The usual rate is between 50 and 60 ft. of descent for 1 deg. F., and seldom exceeds 70 ft.; in the lake Superior region the rate varies from 92 to 122 ft. of descent for an increase of 1 deg. F., and an average of five mines gave 108 ft. of descent for a rise of 1 deg. F. These rates were obtained by taking two points as far apart as possible where conditions could be found that were favorable for reliable observations, i.e. free from the modifying influences of drafts, drainage, drills, blasts, and other working conditions. The upper station in the mine was always taken at such a depth below the surface as to be beyond the influence of atmospheric temperatures. While the facilities for making the observations were not such as to admit of the most refined scientific work, and thus render the results liable to slight modification from more carefully conducted experiments, the data thus approximately obtained are of great value as showing the very cool condition of these very ancient rocks.

SUMMARY OF THE OBSERVATIONS.

Name of Mine.	Depth of lowest observed point.	Temp. at same.	Rate per 1 deg. F.
Atlantic	907 feet.	52.50° F.	98 feet.
Quincy	1931 "	59.50 "	122 "
Osceola	720 "	51.50 "	111 "
Central	1950 "	62.00 "	115 "
Conglomerate	617 "	49.00 "	92 "
		Average	108 feet.

The Corresponding Secretary, Dr. Evers, read a communication from H. C. Ford, Esq., Corresponding Secretary of the Santa Barbara Society of Natural History, Santa Barbara, Cal., offering to send collections of mollusks, fossils, algæ, etc., peculiar to the Pacific coast, in exchange for the "Transactions" of the Academy.

On motion of Mr. Wheeler, the matter was referred to Dr. Hambach, with instructions to ascertain more in detail concerning the collections offered, and power to act.

Mr. W. Brown was elected associate member, and Marchese Antonio de Gregorio was elected corresponding member, as proposed at the last meeting.

The Academy adjourned.

May 4, 1885.

The Academy met Monday evening, May 4th, 1885, at the Academy rooms, President Nipher in the chair, and the following members present: Messrs. Speck, Leete, Moore, Sander, Comstock, Tivy, Hambach, Hunicke, Wheeler, Curtman, Pollak, Gray, and Engler. There were also a number of visitors present.

The Secretary read a letter from Dr. Geo. J. Engelmann, suggesting that the forthcoming number of the Transactions of the Academy be made a memorial number to Dr. Geo. Engelmann, late President of the Academy—to contain a history of the life of Dr. George Engelmann, bearing particularly upon his relations to the Academy, to be written by Dr. Enno Sander—and offering to pay all expenses of said number over the funds in the treasury accruing from regular dues.

On motion of Dr. Curtman, Dr. Sander was appointed a committee to confer with Dr. Geo. J. Engelmann on the subject, with power to act.

The paper of the evening was by Dr. C. O. Curtman, on "The Analysis of Water contaminated with Sewage."

Mr. Gray moved that a committee be appointed to prepare a suitable memorial to the late Albert Todd. The chair appointed Messrs. Gray, Leete, and Sander.

Adjourned.

May 18, 1885.

The Academy met Monday evening, May 18th, 1885, in the rooms of Prof. Potter at Washington University, President Nipher in the chair, and Messrs. Hambach, Sander, Hunicke, Wheeler, Livermore, Tivy, Pollak, Humphreys, Todd, Potter, Moore, Leete, Gray, and Engler, present.

Dr. Sander reported that, in pursuance of the order of the Academy given at the last meeting, he had consulted with Dr. Engelmann, and was now prepared to offer the following resolution, which was adopted:

Whereas Dr. Geo. J. Engelmann has made a proposition to the Academy to pay six hundred dollars ($600.00) towards defraying the expenses of the next number of the Transactions provided that this number will contain a biography of his father, the late Dr. George Engelmann, setting forth his connection with and labors for the Academy, and provided this number be published to the memory of the late President;

Be it resolved, that the Academy accepts the proposition of Dr. Geo. J. Engelmann, and the Secretary be instructed to notify him of this acceptance.

Mr. M. L. Gray reported for the committee appointed at the last meeting the following memorial to Albert Todd:

Mr. President and Gentlemen
of the Academy of Science of St. Louis.—

Your committee appointed to give expression to the feelings of this Society upon the death of our associate and co-worker, Albert Todd, beg leave to submit the following report:—

Albert Todd was born in Otsego county, New York, in 1813; graduated at Yale College in 1836; selected and studied the law as a profession, and settled in St. Louis in 1840, and in a short time thereafter acquired an extensive and lucrative practice. Adding to a vigorous and well trained mind great industry and a thorough preparation of his cases even to the minutest details, he soon rose to the front rank of his profession, and became a worthy compeer of such men as Gamble, Bates, Geyer, Field, and others.

Perhaps the most marked peculiarity of Mr. Todd's character and career as a lawyer, was the indomitable energy and zeal with which he labored for the interest of his clients. No opposition or reverses dismayed him;—they served only to stimulate him to greater exertions to vindicate the right as he saw it.

Yet this sturdy battling in his cases did not lead him to forget or overlook the courtesies and amenities of his profession. He was ever ready to lend a helping hand to his juniors, and encourage in them every laudable effort toward growth and development. The writer hereof takes especial pleasure in referring to this pleasant phase of his character, to which many others, no doubt, can equally bear witness.

After twenty years of active practice in the various branches of the law, during which cases of the greatest difficulty and magnitude were intrusted to his care, and in which the confidence reposed in his learning, ability and skill was never betrayed or forfeited, he gradually, by reason of the loss of the sight of one eye, withdrew from the trial of cases in court, and confined himself to office work for a few attached clients who insisted on retaining him in their services.

As a citizen he was patriotic and public-spirited, thoroughly informed on all prominent and leading questions, and served his country in various important and responsible positions in framing our present State Constitution and the Scheme and Charter of our city.

He gave time, gratuitously, to instruction in the Law School connected with Washington University, and was peculiarly open to all new enterprises that aimed to educate and enlighten, or ameliorate the condition of any and all classes of society. Though in the best sense conservative, he was nevertheless, in an especial degree, free from bigotry, and was always ready to consider and welcome all new measures on their merits; and, when satisfied of their utility, he embraced them with ardor and enthusiasm.

His reading was extensive and varied; not only in history and general literature, but in many departments of science. He was one of the most active members of the Missouri Historical Society, and contributed many items and useful facts to its treasury of historic materials.

Mr. Todd became a member of our Academy in 1856, and of late years has been a constant attendant at the meetings of the Society—has often been elected Vice President, and has frequently presided at our meetings.

His interest in, and devotion to, the usefulness and prosperity of this Academy and of the Historical Society were constant and unflagging. He made especial effort on behalf of both institutions to secure a suitable building for their use, which, however, was not successful; but that fact in no way diminishes the credit to which he is entitled for the endeavor. At the meeting of the Academy of February 15th, 1875 (vol. iii., No. 3, p. 168 of the Academy's Transactions), he proposed a plan for the erection of a $40,000 building, for the use of the two Societies, on the lot acquired of James A. Lucas, practical and admirable in itself, but which, unfortunately, failed for the want of proper support on the part of others.

Although Mr. Todd was not a contributor in the way of written communications to the Transactions of the Academy, yet he added to the interest and instructiveness of our meetings by suggestions and pertinent inquiries that helped to elucidate subjects under discussion, and, what is perhaps better still, he was an intelligent and appreciative listener. This quality in a hearer always stimulates a speaker to utter his best thoughts in the best manner, and without it the eloquence of an orator loses its power. The mention of this quality calls to mind the German proverb, that "Speech is silver, silence is golden."

Mr. Todd took great pleasure in attending our meetings, and remarked to the writer hereof that his only regret in removing to his new residence on Lafayette avenue was that it would to some extent deprive him of attendance at our meetings, and at lectures and other literary and musical entertainments in the central parts of our city.

He loved knowledge and the acquisition of it for its own sake, and, although he was well in years. his thirst for and pursuit after truth was unabated; and all new discoveries were welcomed and enjoyed by him with the keenest zest and relish, and in his feelings he retained all the vivacity and freshness of youth.

His death is a great loss not only to us, but in numerous circles of educational and benevolent enterprises in which he was active and prominent, and his place will be hard to fill. May hallowed benedictions rest upon his memory.

M. L. Gray,
James M. Leete, } *Committee.*
Enno Sander,

By a vote of the Academy it was ordered that the memorial be spread on the records and that a copy be sent to Mr. Todd's family.

Prof. Potter made some remarks on the geological relations of the ore deposits of Missouri. After giving a general description of the geology of the State, Prof. Potter called attention to the fact that it was generally thought, and sometimes by geologists, that ore deposits are of the same age as the rocks in which they occur.

Careful observation had shown that in Missouri this was not the case. In this State the deposits of lead occur mainly in the lower magnesian, except in the Granby and Joplin regions, where they occur in the lower carboniferous limestone. All the lead ore is found in deposits formed later than the rocks inclosing them—not in true fissure veins but in gash veins, and disseminated deposits in openings produced in weathering and filled later with the metal. Of this process of leeching, and subsequent filling with lead, the St. Joe, Desloge and Mine La Motte mines are excellent examples. Lead had never been found in Missouri in the solid unaltered rock. All the deposits are comparatively superficial, and there is evidence to show that these deposits were laid down subsequent to the coal measures.

Academy adjourned.

June 1, 1885.

The Academy met Monday evening, June 1st, 1885, at the Academy rooms, President Nipher in the chair, and Messrs. Hunicke, Wheeler, Tivy, Livermore, Todd, Hambach, Leete, Pritchett, Potter, and Engler, present.

The minutes of the last meeting were read and approved.

The Secretary read a letter from Mrs. Albert Todd, expressing her appreciation of the memorial to her deceased husband which the Academy had placed on record at the last meeting.

Dr. Hambach exhibited an example of a species of *Pionocrinus*, found at St. Charles, Mo., in the St. Louis limestone, which was remarkable because the genus to which it belongs has not been previously found in the United States.

Mr. Wheeler exhibited some specimens of bituminous coal from a coal-pocket in the Lower Silurian sandstone in Crawford county, Missouri.

This pocket is one of the most southern of the numerous isolated local basins, or pockets, of coal that occur in Central Missouri. This pocket has a thickness of 40 feet as far as developed, and may extend farther. As is usual with these displaced and fallen pockets or blocks of coal measures, the coal presents the appearance of having been much crushed and again consolidated, as but little of the bedded character of common coal is to be seen—for the most part looking like consolidated bituminous mud.

As this coal occurs in the heart of the south-west iron ore region, it would be of great economic importance if more reliable in quantity and of better quality. The subjoined analysis of a fair sample at once shows its inferior value for a blast-furnace coke, as the ash is so very high. It should be added, however, that this sample had weathered in the open air for over two years, and hence has probably lost some of its bituminous matter.

Moisture	5.3	per cent.
Volatile matter	27.7	"
Fixed carbon	46.4	"
Ash	20.6	"
	100.0	"

Dr. Todd called attention to the fact that the great function of the biceps muscle is to supinate the hand, and only secondarily to assist the flexor. This action was shown on an arm skeleton which was exhibited.

Prof. Nipher described some curiously formed pot-holes which he had observed in rocks on the Iowa river at Iowa City, and now overlaid with drift.

Mr. J. A. Seddon was elected to associate membership.

Academy adjourned.

June 15, 1885.

The Academy met Monday evening, June 15th, 1885, at the Academy rooms, Vice President Leete in the chair, and Messrs. Moore, Potter, Hambach, Todd, Seddon, Foote, Engler, and visitors, present.

Mr. Holmes Smith was elected to associate membership.

On motion of the Secretary, the Librarian was authorized to exercise his discretion in disposing of duplicate copies of journals in possession of the Academy.

Dr. Leete asked the attention of the Academy to the following paper, entitled

SOME FACTS CONCERNING PAST VISITATIONS OF CHOLERA.

The first detailed account of the disease that is now commonly called either cholera, or Asiatic cholera, was published early in the 16th century, and during that century many successive descriptions of the disease exhibited its extreme violence and mortality. To the Portugese who invaded India in 1498, and to the Dutch, English and French who invaded it but little later, the world is indebted for those early accounts of a disease which they found in the low lands of India, and which they doubtless acquired, carried with them, and spread. Of the practical value of those accounts but little is known. It is certain, however, that European and American physicians, generally, did not become deeply interested in the study of cholera until the latter part of the first third of the present century. The wide dissemination of cholera is dated from the Indian epidemic of 1817. It will be remembered that in that epidemic the disease was of unusual severity, particularly among the British troops, and was quite rapidly carried over ninety degrees of longitude and sixty-six degrees of latitude. Toward the latter part of 1823 it had appeared in Astrachan on the north side of the Caspian sea. This fact was of special interest to European physicians. After six years cholera appeared again in Russia, and there were such reasons for believing it would soon reach England that the British government sent two physicians to meet the disease in Russia and study its characteristics. Steadily marching westward, the cholera reached the eastern shore of England in November, 1831.

How wide-spread and destructive cholera was in Europe during 1831–'32, and how it was brought to this country and disseminated, is familiar to all. The epidemics of cholera that have subsequently swept over both Europe and America have not differed from the first either as to the characteristics of the disease or the means by which it is spread. That cholera has its origin in India is commonly believed, but just how it originates has not been discovered. If such density of population, such high mean temperature and rainfall, such extreme poverty and domestic hardship, and such domestic filthiness as can be found in India above every country, are, when properly conjoined, sufficient to produce cholera, then its constant prevalence in the low lands of India need not occasion surprise.

It is commonly believed that cholera is produced by a specific poison; but what that specific poison is has not been determined. Dr. Robert James Graves, of Dublin, was, I believe, the first to point out that cholera in its progress, whether by land or water, seems regulated by no common physical circumstances, *except human traffic and human intercourse*. This he did in a lecture which was, I believe, first published in 1843, but possibly not earlier than 1848. He clearly showed that cholera was carried by land no faster than men traveled, and by water no faster than ships sailed.

The literature of cholera shows that the most eminent medical writers in Europe and America were slow in appreciating the correctness and the value of Dr. Graves's observations. During the American epidemic of cholera (1832–35) Dr. W. E. Harner, Professor of Anatomy in the University of Pennsylvania, described an exfoliation of the epithelial lining of the alimentary canal, whereby the extremities of the venous system of the part are denuded, as being characteristic of cholera alone. In 1849 Dr. Sam'l Jackson, Professor of the Institutes of Medicine, and Dr. John Neill, Demonstrator of Anatomy in the University of Pennsylvania, in conjunction with Dr. William Pepper and Dr. Paul B. Goddard, presented a report to the College of Physicians of Philadelphia, in which they, too, showed that the epithelial layer of the intestinal mucous membrane was either entirely removed, or was detached, adhering loosely. This important fact—the most important, perhaps, in the mechanism of cholera—was confirmed seventeen years later by the eminent pathologist Dr. Lionel S. Beale, of London, Eng., who, referring to the remarkable character of the intestinal discharges and the matter found in the small intestines, added, "This has been proved to consist entirely of columnar epithelium, and in very many cases large flakes can be found consisting of several uninjured epithelial sheaths of the villi. In bad cases it is probable that almost every villus, from the pylorus to the ilio-canal valve, has been stripped of its epithelial coating during life. These important organs (the villi) are, in a very bad case, all or nearly all left bare, and a very essential part of what constitutes the absorbing apparatus is completely destroyed. It is probable that the extent of this process of denudation determines the severity or mildness of the attack."

In 1849 Dr. John Snow, of London, in investigating some circumscribed outbreaks of cholera in Harsleydown, Wandsworth, and other places, came to the conclusion that, in these instances, the disease arose from cholera evacuations finding their way into the drinking-water. Subsequent investigations in London, and in particular one conducted in 1854 by a committee appointed for that purpose, and in whose labors the never-to-be-forgotten Broad-street pump figured conspicuously, left no room for doubt that cholera could and had been spread, as Dr. Snow had pointed out, by drinking water contaminated by cholera dejections.

Dr. Snow's suggestions regarding the introduction of the poison of cholera and other specific poisons into the human system by means of drinking-water have not yet been appreciated, even by the medical profession, at their proper value. The observations of Graves as to how cholera is carried from place to place or from country to country; and of Snow as to how the poison of cholera may be taken into the system by means of fouled drinking-water, in view of the fact that their correctness has been corroborated, ought to have greater weight generally with physicians and all intelligent persons than they have had up to the present time. For physicians the observations of Harner, Jackson, Neill, Pepper, and Goddard, corroborated by the more detailed and complete observations of Beale in respect of the effect of cholera poison upon the alimentary canal, have, I believe, a much greater practical value for their guidance, both in preventing and curing cholera, than has yet been attached to them.

Mr. Moore exhibited a map of St. Louis showing the districts in which deaths from cholera had occurred in 1866.

On proper motion, the Academy adjourned till the third Monday in October.

October 19, 1885.

The Academy met Monday evening, Oct. 19, 1885, at the Academy rooms, with President Nipher in the chair, and the following members present: Dr. Evers, Dr. Hambach, Mr. Wheeler, Dr. Todd, Mr. Tivy, Dr. Sander, Dr. Pollak, Mr. Seddon, Judge Speck, Dr. Leete, Prof. Pritchett, and Mr. Engler.

Upon proper motion, and after examination of their respective publications, the following societies were placed upon the exchange list of the Academy: "Universität und Landes Bibliothek," Strassburg; "The Botanical Society of Lanshut," of Bavaria; "Scientific Association of Meriden, Conn."; "Society of Natural History," Brookville, Franklin Co., Ind.; "Natural History Society," Sedalia, Mo.

The receipt was acknowledged, with thanks, of the following donations to the library of the Academy: "Maps of the City of St. Louis, prepared for the 12th Annual Meeting of the American Public Health Association, Oct. 14–18, 1884," presented by Mr. Robert Moore; "Official Map of the City of St. Louis," presented by Mr. L. Boedicker: "Proceedings of the American Pharmaceutical Association, 1884," presented by Mr. J. M. Good.

A paper by Prof. G. C. Broadhead on the "Geological History of Missouri," and a paper by Mr. C. J. Reed, of Burlington, Iowa, on "The Graphical Representation of the Relation between Valence and Atomic Weight," were referred to the Committee on programme.

Prof. Nipher read a paper on "The Iso-dynamic Surfaces of the Compound Pendulum," which was referred to the Committee on Publication.

Dr. Hambach exhibited a single garnet crystal, weighing 3 lbs., which he had obtained at Salida, Colorado; also a beautifully preserved fossil palm-leaf from Fossil Station, Wyoming.

Adjourned.

November 2, 1885.

The Academy met Monday, Nov. 2d, 1885, at the Academy rooms, President Nipher in the chair and the following members present: Messrs. Leete, Todd, Foote, Tivy, Sander, Adams, Luedeking, Hambach, Evers, Wheeler, and Engler.

The minutes of the last meeting were read and approved.

A paper by Mr. C. J. Reed, ofBurlington, Iowa, on "The Graphical Representation of the relation between Valence and Atomic Weight," was read and explained by Dr. Chas. Luedeking.

This paper together with a paper on "The Specific Heats, Specific Gravities, and the Heats of Hydration of the Acids of the Fatty Series and their mixtures with Water," by Dr. Charles Luedeking, and a paper by Prof. G. C. Broadhead on "Missouri Geographical Surveys," were referred to the Committee on Publication.

Prof. Wm. Trelease, of the Shaw School of Botany, of Washington University, was elected to associate membership, and Sr. Angel Anguiano, Director del Observatorio Nacional de México, was elected to corresponding membership.

After some informal remarks upon the contamination of the water of surface wells by the excreta of men and animals, and the ability of this water to propagate cholera germs, the Academy adjourned.

November 16, 1885.

The Academy met Monday evening, Nov. 16th, 1885, at the Academy rooms, Vice Presid't Dr. Leete in the chair, and Messrs. Moore, Sander, Seddon, Tivy, Pollak, Wheeler, Trelease, Evers, Hambach, and Engler, present.

The minutes of the last meeting were read and approved.

The Academy acknowledged, with thanks, the receipt of "A Sanitary Survey of St. Louis, 1884," presented by Mr. Robert Moore; "Autobiography and Reminiscences of the late August Fendler, edited by Wm. M. Canby," presented by Mr. G. W. Letterman.

Upon the recommendation of the Corresponding Secretary, the "Elliott Society of Science and Art," Charleston, S. C., was placed upon the exchange list of the Academy.

Mr. Wheeler called attention to a new locality for the rather rare and usually sparingly-found mineral known as Pickeringite, or natural magnesian alum. At Castle Valley, Utah, it was found by him in 1882, in seams several inches thick, in the lignite-coal beds of that region. He also called attention to the quaquaversal uplift known as the San Rafael Swell, in Castle Valley, as being possibly of laccolitic origin, though, as it had not been studied, its character is problematical. The nature and occurrence of the phenomena of laccolites, as described by Gilbert in his "Geology of the Henry Mountains," was explained.

Prof. Trelease exhibited a specimen of the plum-like fruit of the maiden-hair tree (*Salisburia adianti folia*), and remarked on its structure saying that this was the first instance in which the species had been observed to fruit in St. Louis. The specimens were obtained from a tree, not far from fifteen years old, growing in the Missouri Botanical Garden. The species is diœcious, and for this reason many trees are sterile; but pistillate trees have been noticed to fruit for some years past at Central Park, New York city, and about Philadelphia.

Prof. Trelease also laid on the table two specimens of so-called jumping-beans, which had been sent to Mr. Henry Shaw by a St. Louis lady. These specimens, which he thought were similar to others that had been shown on previous occasions by Prof. Riley, were shown to be the carpels of a euphorbiaceous fruit; and, on opening them, the motion manifested was shown to be due to a lepidopterous larva which had effected an entrance while young, and had eaten the developing seed. After giving a brief résumé of the literature of the subject, Prof. Trelease mentioned the seed-like oak-galls, sometimes known as jumping-seeds, which are singularly moved by the larvæ they contain, and touched briefly upon the power of locomotion possessed by certain grass-fruits, such as the "animated oats," the fruit of sweet vernal grass, etc.; as well as the self-burying fruits of erodium, stipa, certain species anemone, etc., showing that in these cases the power of movement resides in the fruit or its appendages, and is useful in disseminating or planting the contained seed.

Adjourned.

December 7, 1885.

The Academy met Monday evening, Dec. 7th, 1885, at the Academy rooms, President Nipher in the chair, and Messrs. Hambach, Trelease, Adams, Tivy, Leete, Seddon, Foote, Wheeler, Smith, and Engler, present.

The minutes of the last meeting were read and approved.

Dr. Sander gave some account of analyses made by him of samples of the condensed milk manufactured by the Highland Condensed Milk Company of Illinois, and directed particular attention to the fact that this condensed milk differed from that made in Switzerland, and elsewhere, in that evaporation was stopped earlier in the process of condensation and that no sugar was added, as shown by the following table giving the analyses commonly accepted of the Ordinary Milk (uncondensed), European Condensed Milk (upon the authority of Elsner), and the Highland Condensed Milk, from an average of ten samples:

In per cent.	Ordinary.	European.	Highland.
Fat	3.5	10.98	13.99
Nitrogen substances	4.0	12.32	11.70
Sugar of milk	5.0	16.29	15.53
Ashes	0.7	2.62	2.20
Water	86.8	26.61	56.58
Sugar (added)	—	31.18	—
	100.00	100.00	100.00

Dr. Sander remarked that he had kept samples of the condensed milk in his office for several weeks during the hot weather of July, and it had remained sweet.

Mr. Engler exhibited and described the construction of a model of a Single Curved Surface with a Helical Directrix, sometimes known as a Developable Helicoid.

Prof. Trelease exhibited specimens of the Chinese water chestnut (*Trapa bicornis*), which were offered for sale on one of the streets of St. Louis, and remarked on their structure.

With them he had obtained a few specimens of a globular dry fruit about 1½ inches in diameter, which proved to be the Chinese "lychee," figured by Gaertner (Fruct. et Semin. vol. i., p. 198, pl. 42) as *Scytelia chinensis*. This was said to be one of the *Sapindaceæ*, now known as *Nephelium litchi*, according to the "Genera Plantarum" of Bentham and Hooker. Each fruit contains a single large seed, surrounded by a fleshy aril, resembling raisins in smell and taste in the specimens shown: this constitutes the edible part of the fruit. To it Gaertner applied the name "*Pruni damasceni*." According to Mott (Fruits of All Countries, p. 9), a similar but smaller fruit is known in China as "longan" or "long yan."

In connection with these fruits, it was stated that

an itinerant had been reaping a rich harvest of two-cent pieces from the sale of what he called "the genuine cinnamon-bean of the West Indies, that the oil is made from." Though the chocolate-colored cinnamon-scented "beans" were cried only as desirable substitutes for sachets, the vendor did not hesitate to assure the speaker that they were fresh, and would all grow if planted. Interspersed with them were very fresh-looking leaves that were said to be the foliage of the bean-plant. Unfortunately for the peddler's veracity the "beans" proved to be the cheapest kind of confections saturated with cinnamon, while the leaves were nothing but pinnæ of a common shield-fern (*Aspidium acrostichoides*).

The speaker mentioned the cinnamon-bean humbug as one that he had noticed in other cities. While the "beans" bore not the slightest resemblance to any sort of fruit, they seemed to meet with a ready sale.

Prof. Nipher exhibited models of the Reis telephone receiver and transmitter. The transmitter was the bored block form, and the receivers were the knitting-wire and electro-magnetic form. He stated that he found no difficulty in operating them, and that they operated precisely in the same way as the modern telephone. The only difference was that in the modern telephone the contacts were of carbon and the range of adjustment greater, so that it was easier to operate the instruments successfully. Similarly, and probably for the same reason, an arc light between carbon points has a greater range of adjustment than one between metal points.

Adjourned.

December 21, 1885.

The Academy met Monday evening, Dec. 21st, 1885, at the Academy rooms, President Nipher in the chair, and Messrs. Hambach, Pritchett, Evers, Luedeking, Tivy, Todd, Pollak, Gray, Jewett, Seddon, Wheeler, Leete, Engler, and three visitors, present.

The minutes of the last meeting were and approved.

On motion of the Corresponding Secretary, there were added to the exchange list the following: "Société Khediviale de Géographie," Cairo, Egypt; "Zeitschrift der historischen Geselschaft von Posen," Posen, Prussia; "Observatorio Nacional de México," Tacubaya, Mexico.

Prof. H. S. Pritchett exhibited and described Eastman's Personal Equation Machine. The machine is the invention of Prof. J. R. Eastman, of the Naval Observatory. Its purpose is the determination of the personal error of an observer in noting the transit of a star across the wire of a micrometer. The results obtained from this machine are very good, and compare well with results of relative personal equation from star observations.

Mr. H. A. Wheeler called the attention of the Academy to the use of iodine in blow-piping. He said that

the very delicate and characteristic iodide reactions, as first brought out by Dr. Haanel with hydriodic acid on plaster-of-Paris tablets, were now capable of being reproduced with simple dry reagents. A first improvement over the use of hydriodic acid by the substitution of tincture of iodine was brought before the Academy last year, in which it was shown that this simple non-decomposing alcoholic solution of iodine accomplished the same results as the readily decomposable acid, which also requires considerable trouble to prepare.

Further experiment showed that the simple iodine crystals would also give these reactions with the sulphides of the volatile elements, while, if flowers-of-sulphur were intimately mixed with the other compounds of these elements, it was found that the iodide coats could be reproduced under all circumstances. By this method the great step is made of substituting dry for liquid reagents which is such a valuable feature in the compact blowpipe outfit, in which portability is a very salient feature. Both of these dry substances are of cheap and common occurrence, are easily carried, and possess all the delicacy and advantages of hydriodic acid when similarly employed.

Dr. Hambach exhibited a very fine specimen of a fossil crocodile, 12 feet in length, found by him during the last summer at Fossil Station, Wyoming. The specimen was almost perfectly preserved. Dr. Hambach remarked that he had not yet had opportunity to classify it, but would make this the subject of a future communication.

Mr. Isaac N. Judson was elected to associate membership as proposed at the last meeting.

Academy adjourned.

January 4, 1886.

The annual meeting of the Academy was held on Monday evening, Jan. 4th, 1886, at the Academy rooms, President Nipher in the chair, and Messrs. Hambach, Evers, Tivy, Luedeking, Jewett, Adams, Pollak, Foote, Seddon, Gray, Leete, Potter, Smith, and Engler, present.

The minutes of the last meeting were read and approved.

The President made the following annual report:

Gentlemen of the Academy,—

At the close of the year it becomes my duty to make a formal report on the work of the past year. In doing so I am glad to say we have accomplished enough to put us distinctly in advance of our position at the beginning of the year. We are out of debt, and with enough of surplus funds to warrant us in at once proceeding with the new number of the Transactions, the material for which is already provided, and which will soon be put in final shape for publication. With some efforts on the part of our members, our meetings have been made interesting by a concerted action effected through a Committee of arrangements. We have thus always been provided with something of interest at each meeting of the Academy. It is to be hoped that we will constantly adhere to this plan. But at the same time we must bear in mind the fact that this is not the main function of an Academy of Science. It is not a school, nor a place of entertainment. It is primarily an organization for the real enlargement of the boundaries of knowledge. Our object in maintaining the Academy is not that of receiving personal benefits. nor of instructing each other. but of discovering and publishing that which was not before known. Whatever we do should be done with that ultimate object in view. It does often happen that our contributions take the form of short lectures on familiar subjects. This comes about through the fact that we are comparatively few in numbers, and the struggle for a fair living is one which to most of us has a well understood meaning. We can only give to science such time as we have — after we have complied with more imperative demands. It therefore happens that we cannot enjoy the luxury of original papers, except at intervals. But it is important that our meetings should be held at regular intervals, and that we should do whatever is necessary in order to keep up the interest of the meetings.

In our country, and particularly in the newer portions where the great demand of society is for material growth, science is at a great disadvantage. The call is for men who can build new industries, who can design machinery or plan and superintend engineering projects, and our technical schools are intended to supply this want. We are building our houses, and are full of bustle and business. Some day we hope to finish them, and to move in and begin to live.

But in truth it is a subject for grave consideration that there are almost no inducements to cause a young man of ability to devote his energies to pure scientific research. It requires a kind of austere asceticism, a renunciation of the things most prized by the average man of affairs, which it is becoming more and more difficult to find. To men who have had the advantages ot the training given in our technical and scientific schools, and who see the great advantage which such a training gives them, the temptation to enter the list and join in the scramble is almost irresistible. And it is praiseworthy for one to do this. But there is no such inducement for one to devote himself to the service of pure science, to become a pioneer in the advanced guards of civilization. The value of his work is not understood even by himself, and it cannot be paid for by the job. And yet all the great material advances of modern times are based upon such work.

I do not suppose it is profitable for us to quarrel with the situation, for it is not likely that we can change it. If the tendency is a wrong one, it is possible that it may right itself in time. The disposition of some of our men of wealth to give largely to the higher schools is a most encouraging one. In any case, our own duty is clear. It is ours to keep alive the sacred fires in St. Louis. It may be that the results of our work will not be all that we could wish; it is enough if they are as great as the circumstances would permit.

During the last year we have had seventeen meetings, with an average attendance of twelve. At these meetings communications were made on thirty-five different subjects, or on an average two subjects for each evening.

Thirteen associate members have been added during the year, as against six during the preceding year, and four corresponding members were added.

During the year we have lost two of our oldest members, Mr. A. Todd and Dr. I. Forbes, the latter having been a charter member.

I also saw in November last, in a New York paper, a notice of the death of Dr. Gustavus Seyffarth, who formerly did so much work in the direction of interpreting the Egyptian hieroglyphics. He was buried on the 19th of last November.

The following report was submitted by the Corresponding Secretary:

Mr. President and Gentlemen,—

The work of the Corresponding Secretary during the past year has not been very burdensome, owing to the fact that our "Transactions" had not been ready for distribution. During the year we have added to our list of foreign exchanges six (6) new Societies, and have lost two (2), both of which have ceased to exist. This gives us 268 foreign exchanges. To our home list we have added eight (8) Societies, making a total of 140. The grand total of our exchanges numbers 408 Societies. To our list of corresponding members we have added four, namely: Prof. A. von Dankelman, of Berlin; Dr. Theo. S. Case, Kansas City; Prof. Angel Anguiano, Mexico; Marchese Antonio de Gregorio, Palermo.

It is impossible to make out a complete list of the corresponding members now living, as we are not always informed of the deaths. Among the prominent members who have died this year may be mentioned Dr. Seyffarth, Prof. Thos. Davidson, and Gen. Geo. B. McClellan, the latter of whom had been a corresponding member since 1857.

We have received 399 books and pamphlets during the year by exchange and 40 by donation; in all, 439. Of these, 292 are volumes and 14 are pamphlets.

Eighteen letters were written during the year in answer to correspondents, and in informing corresponding members of their election, and 54 acknowledgments to various Societies of the receipt of their exchanges sent out.

Three dollars and eighty-five cents was expended for postage, postal cards, and envelopes, and $5.00 still remains in the hands of the Corresponding Secretary. No receipts.

Respectfully submitted, Edw. Evers, *Cor. Sec.*

Specified List of Exchanges.—United States and Canada, 140; Germany, 108; Great Britain, 32; France, 31; Italy, 18; South America and Mexico, 15; Holland, 12; Switzerland, 12; Russia, 10; Belgium, 9; East India, 7; Spain, 6; Sweden, 5; Denmark, 3.

In lieu of a report, the Treasurer sent the following communication:

Prof. F. E. Nipher, Pres't Academy of Science of St. Louis.

Before my departure for Europe I intended to render a full report to the Academy of the financial standing, but regret that it was impossible for me to find time to do so. However, I can state that the Academy, according to my accounts, has $127.20 to draw against, and I have authorized my cashier to honor any bill of the Academy that has been signed by the President and Secretary, whatever amount it may be.

Respectfully yours, Enno Sander.

The following donations to the Academy library were received with thanks: United States Census Report, 1880, from Dr. Evers; Publications of the Iowa Weather Service, presented by Dr. Hinrichs.

The Corresponding Secretary was instructed to complete the file of the Academy's "Transactions" at the library of the University of Strassburg.

Mr. Eliot C. Jewett described a very practical method, adopted by himself, for determining very quickly, and with accuracy much within the limits af a carat, the value of alloys of gold and silver based upon a determination of their speeific gravities.

By a large number of determinations he had found that the relation between the specific gravity and the value of these alloys was very nearly constant, and, by plotting this relation in a large number of cases by the use of the ordinary system of coördinates, the resulting curve seems to be approximately a straight line, for each point of which the abscissa represented the specific gravity and the ordinate the value of the alloy. This empirical chart was based npon so many cases that it served with all needed accuracy for quick determination. The whole process of ascertaining the specific gravity of the sample to be tested, and of reading from the chart the corresponding value, need not occupy over three or four minutes.

Prof. Nipher made some remarks, which he illustrated by a chart, upon "The mean Temperatures for the month of December, in St. Louis, from 1840 to 1885."

The following officers for the year 1886 were elected:

President—Francis E. Nipher.
First Vice President—Dr. James M. Leete.
Second Vice President—Mr. M. L. Gray.
Corresponding Secretary—Dr. Edward Evers.
Recording Secretary—E. A. Engler.
Treasurer—Dr. Enno Sander.
Librarian—G. Hambach.
Curators—Dr. Chas. Luedeking, Dr. Gustavus Hambach, Wm. H. Allderdice.

Mr. W. A. Haren was elected to associate membership.

Adjourned.

January 18, 1886.

The Academy met Monday evening, Jan. 18th, 1886, at the Academy rooms; Dr. Leete, Vice President, in the chair, and Messrs. Speck, Evers, Jewett, Haren, Tivy, Wheeler, Seddon, Pritchett, Moore, Engler, and visitors, present.

The minutes of the last meeting were read and approved.

A map of the City of St. Louis was presented to the Academy showing death-rate per block during the cholera in 1866, which was indicated by different colorings.

Mr. John H. Kinealy was elected to associate membership.

The Academy then adjourned to accept the invitation which had been extended by Prof. Pritchett to an informal inspection of the new observatory and clock-room.

February 1, 1886.

The Academy met Monday evening, Feb. 1st, 1886. President

Nipher in the chair, and Messrs. Speck, Seddon, Wheeler, Tivy, Engler, Adams, Leete, and Smith, present.

The minutes of the last meeting were read approved.

On motion of the Corresponding Secretary, the Technical Society of the Pacific coast was placed on the exchange list.

The President appointed Messrs. Engler, Leete, and Seddon, as a committee on programme for the ensuing year.

Mr. Seddon made some very interesting remarks which were suggested to his mind by the paper, read by Mr. Jewett at a previous meeting, on "The relations between the specific gravities and the value of alloys of gold and silver." Mr. Seddon showed by means of a chart how it was possible to indicate by means of mathematical curves the relations existing between the specific gravity and the value of alloys of any two metals, provided that it were possible to determine the relations of the volumes of the metals considered. As this latter relation, even in the simplest cases, has never been determined, the results based upon any assumed law must necessarily be inaccurate.

Prof. Nipher exhibited and demonstrated the uses of Thomson's Quadrant Electrometer.

Adjourned.

February 15, 1886.

The Academy met Monday evening, Feb. 15, at the Academy rooms. President Nipher in the chair, and the following members present: Messrs. Leete, Gray, Hambach, Evers, Tivy, Hunicke, Seddon, Wheeler, Adams, and Engler.

The minutes of the last meeting were read and approved.

Dr. Hambach made some interesting remarks on "The Classification of *Blastoids*," in which he called particular attention to the importance of classifying them according to the construction of their summit openings.

Adjourned.

March 1, 1886.

The Academy of Science met Monday evening, March 1st, at the Academy rooms, Vice President Leete in the chair, and the following gentlemen present: Messrs. Evers, Tivy, Seddon, Nipher, and Engler.

The minutes of the last meeting were read and approved.

Prof. Nipher exhibited and explained the uses and proper manipulation of a Comparator made by the Physical Society of Geneva, Switzerland.

Adjourned.

March 15, 1886.

The Academy of Science met Monday evening, March 15th, at the Academy rooms. President Nipher in the chair, and Messrs. Leete, Evers, Hambach, Tivy, Seddon, Smith, and Engler, present.

The minutes of the last meeting were read and approved.

On recommendation of the Corresponding Secretary, the "Journal of the Trenton Natural History Society" was placed upon the exchange list.

The Academy was much interested in the examination of a number of microscopical preparations received by Dr. Evers from Europe, showing *Bacillæ*.

Mr. O. B. Wheeler was elected to associate membership.

Adjourned.

Exchanges received in 1878-9.

Upsala—K. Vetenskaps Societeten: Nova Acta, ad celebranda Solemnia quadringenaria Univ. Upsaliensis, 1877.

Christiania—K. Norska Universitet i Christiania: Om Poucelet's Betydning for Geometrien, et cet., af Elling Holst, 1878; Le Royaume de Norwége et le Peuple Norwégien, par le Dr. O. J. Broch, 1876; On Magnets, by O. A. L. Pihl, 1878; Bidrag til Kundskaleen om Norges Arktiske Fauna—I. Molluska Regionis Arcticæ Norwegiæ, af Dr. G. O. Sars, 1878; Ringen i Forza Kirhe, af Sophus Bugge, 1877; Om Stiaficalionens Spor, af Dr. Theo. Kjerulf, 1877.

Lund—Universitas Carolina-Lundensis: Accessions-Katalog, 1876, 1877, 1878; Acta. T. ix.-xiv., 1872-78.

Copenhagen—K. Danske Videnskabernes Selskab: Obersigt. No. 3, 1876; Nos. 1-3, 1877; Nos. 1-2, 1878; Nos. 1-2, 1879;—Himantolophus og Ceratius, af Dr. Chr. Lütken, 1878; Questions pour l'Année 1878; *Cœlodon*, af J. Reinhardt, 1878; *Grypotherium Darwinnii*, af J. Reinhardt, 1879.

Dorpat—Dorpater Naturforscher Gesellschaft: Sitzungsberichte, Band iv. Heft 3. 1877; v. 1. 1878;—Archiv, Band vii. 4; viii. 1.-3, 1877;—Meterol. Beobachtungen, 1876. von Dr. Karl Weirauch, Dorpat, 1878; Archiv für der Naturkunde, 1879: Geognostische Karte von Dr. C. Grewingk.

Moscow—Société Imp. de Naturalistes: Bulletin, 1-4, 1876; 1-4, 1877; 1-2, 1878;—Mémoires, T. xiii. 5, 1876.

Riga—Naturforscher Verein: Correspondenzblatt, 22 Jahrg. 1877.

St. Petersburgh—Académie Impériale des Sciences: Mémoires, T. xxiv., 4-11; T. xxv., 1-9, 1877-8: T. xxvi., 1-11, 1878;—Bulletin, T. xxiii., 3-4; T. xxiv., 1-3; T. xxv. 1-2.

Société Impériale Géographique de Russie: Proceedings, 1878-9.

Imperial Botanical Garden: Acta Horti Petropolitani, T. iv., 1-2, and Supp. to T. iii. 1876; T. v. 2, 1879; T. vi. 1, 1879.

Amsterdam—K. Akademie van Wetenschapen: Verhandelingen, Afd. Naturkunde, Dl. xvii.-xviii.—Letterkunde, Dl. ix.-xi.; Verslagen, Afd. Naturkunde, Dl xi.-xiii.—Letterkunde, Dl. vi.-vii. 2, 1878; Jaarboek, 1876-7; Procès-Verbal, 1876-8; Prijvers Pastor Bonus Idylia aliaque Poemata, 1878.

Société Royale de Zoologie: Linnæana in Nederland, aanwezigen; Plechtige Herdenking van Linnæus' Leven en Werken—Rede van Carolus Linnæus, door Dr. C. A. J. A. Oudemans, 1878; Openingsplechtigheid van de Teutonstilling, 1878.

Middelberg—Zeuwsche Genootschap der Wetenschappen: Archief, iii. Deel, 3 Stuk, 1878; iv. Deel, 2 Stuk, 1879.

Harlem—Société Hollandaise des Sciences: Archives, T. xi. 4-5; T. xii. 1-5; T. xiii. 1-3.

Utrecht—K. Nederlandisch Meteorologisch Institut: Jaarboek 1875, 27 Jahrg. 1876: Annuelle Thermomètre et du Baromètre en Néerlande 1843-75, Utrecht, 1876; Meterol. Jaarboek voor 1872, Utrecht, 1877; Meteorol. Jaarboek 1876, 1 Deel 1877; Observations Météorol. des Stations du second Ordre dans les Pays-Bas 1876, Utrecht, 1877; Jaarboek voor 1878, Utrecht, 1879.

Leiden—Nederlandische Dierkundige Vereeniging: Tijdschrift, Deel iv., 1879

Berlin—K Preuss. Akademie der Wissenschaften: Monatsberichte, Sept.-Oct. 1877, to Aug. 1879.

Verein für Beförderung des Gartenbaues: Monatsschrift, Jan.-Dec. 1877, to Jan.-Dec. 1878.

Zeitschrift für die gesammten Naturwissenschaften: Band xiii.-xiv. 1876: Band i. 3 folge, 1877; Band iii. folge 3, 1878

Bonn—Naturhistorischer Verein der Preuss. Rheinlande u. Westphalens: Verhandlungen, 4 folge, 5-6 Jahrg. 1877-9.

Dresden—Naturwissenschaftliche Gesellschaft: Isis—Sitzungsberichte, Jahrg. 1877; Juli-Dec. 1878; Jahrg. 1878-1879.

Verein für Erdkunde: xv. Jahresberichte, Geschaftlicher Theil 1878; Wochenschaftlicher Theil 1878.

Dürkheim—Pollichia: Naturwis. Verein der Bayerischen Pfalz—Jahresbericht, Band xxxiii.-xxxv. 1875-77.

Dantzig—Naturforschende Gesellschaft: Schriften, iv. Band, 1-2 Heft, 1877-8.

Frankfurt-a.-M.—Senckenbergische Naturforschende Gesellschaft: Abhandlungen, xi. Band, 2-3 Heft, 1878; Bericht 1876-7 und 1877-8.

Ærzlichen Verein: Jahresberichte, xxi. Jahrg. 1877; Statistische Mittheilungen über den Civilstand der Stadt Frankfurt-a.-M. 1878.

Der Zoologische Garten: Zeitschiift, Jahrg. xviii.-xx. 1-6, 1879.

Freiburg I. B.—Naturforschende Gesellschaft: Verhandlungen, Band vii. 2-3 Heft, 1878.

Giessen—Oberhessische Gesellschaft für Natur-und-Heilkunde: xvii. Bericht, 1878.

Görlitz—Naturforschende Gesellschaft: Abhandlungen, xvi. Band, 1879.

Göttingen—K. Gesellschaft der Wissenchaften: Nachrichten, Jahre 1877 und 1878.

Halle—Naturforschende Geselischaft: Abhandlungen, xiii. Band, 4 Heft, 1877; xiv. Band, 1-3 Heft, 1878-9;—Festschrift zür Feier des Hundertjahrigen Bestehen, 1879.

Verein für Erdkunde: Mittheilungen, 1877-8.

Hamburg—Naturwissenschaftliche Verein: Verhandl. 1873-78, neue folge 1-3.

Bremen—Naturwissenschaftliche Verein: Abhandlungen, v. Band, 3-4 Heft, 1877-8; vi. Band. 1 Heft, 1879;—Beilage, No. 6, 1877.

Leipzig—K. Sachsische Gesellschaft des Wissenchaften: Berichte, math.-phys. Classe, ii.-iv. 1875; i.-ii. 1876; i.-ii. 1877; 1 Heft, 1878;—Jahresbericht der Fürstlich Jablonowskischen Gesellschaft, 1878-79.

Naturforschende Gesellschaft: Sitzungsberichte, Jahrg. i.-iii. 1874-77; Jahrg. iv. 1877; Jahrg. v. 1878.

Zoologische Anzeiger: i. Jahrg. No. 10, 1878; No. 1-43, 1879.

Munich—K. Bayerische Akademie der Wissenschaften: Sitzungsberichte, philos. Classe, 1877, 2-4; math. Classe, 1877, 2-3; Almanach 1878: Annalen der Sternwarte, Supp. zu Band xxi.; Sitzungsb. phil.-philolog. historische Classe, Heft 2-4, 1877; math.-phys Classe, Heft 3, 1877; Bestimmung der geograph. Breite der K. Sternwarte bei München, 1877; Almanach 1878; Aventin und seine Zeit; Rede von J. V. Doellinger, 1877: Sitzungsb. 1878, Heft 1-4; Band ii., Heft 1-2, phil.-philolog. u. historische Classe; 1878, 1-4 Heft, math. Classe; Meteor. Beobachtungen 1876-78; Sprengel, Komödie; Baeyer, Synthese.

Regensburg—K. Baierische botanische Gesellschaft: Flora, 35 Jahrg. 1877; 36 Jahrg. 1878.

Zoologische-mineralogischen Verein: Correspondenz-Blatt, 31 Jahrg. 1877; 32 Jahrg. 1878; Abhandlungen, 11 Heft—Die Gastropoden der Alpen, von Dr. Ludwig von Ammon, München, 1878.

Historische Verein von Oberpfalz und Regensburg: Verhandlungen, 32-33 Band, 1877-78.

Stettin—Entomologische Verein: Zeitung, 39 Jahrg. 1878.
Stuttgart—Verein für Vaterlande Naturkunde: Jahreshefte, 34-35 Jahrg. 1878-79.
Wien—K. K. Akad. der Wissenschaften: Sitzungsberichte, math.-naturw. Classe, Band lxxiv.-lxxvii. 1877, Band 1-2; 1878, Band 1-2.
K. K. Geographische Gesellschaft: Mittheilungen, xiv. Band, 1876; xx. Band, 1877; xxi. Band, 1878.
K. K. Central-Anstalt für Meteorologie und Erdmagnetismus: Jahrbücher, neue folge, x. Band, Jahrg. 1873, Wien, 1875; xi. Band, Jahrg. 1874, Wien, 1876; xii. Band, 1875; xiii. Band, 1876.
Verein zür Verbreitung naturw. Kentnisse: Schriften, xviii. Band, 1878; xix. Band, 1878-9.
K. K. zool.-botanische Gesellschaft: Verhandlungen, xxvii. Band, 1878; xxviii. Band, 1879.
K. K. Geologischen Reichsanstalt: Jahrbuch, xxvii. Band, No. 3, 1877; xxix. Band, No. 2. 1879; Verhandlungen, 1877-79, Nos. 1-9
Anthropologischen Gesellschaft: Mittheilungen, Band vii.-ix. 1-6, 1877-1879
Wiesbaden—Verein für Naturkunde: Jahrbücher. Jahr. xxix. und xxx., 1876-7.
Würzburg—Physikalisch-medicinische Gesellschaft: Verhandlungen, xi.-xiii. Band, 3-4 Heft, 1877-9.
Emden—Naturforschende Gesellschaft: 26 Jahresbericht, 1876; 27 Jahresbericht für 1877.
Hermannstadt—Siebenburgischen Verein für Naturwissenschaften: Verhandlungen, xxviii.-xxix. Jahrg. 1879.
Linz—Vaterlandische Museum Francisco-Carolinum: 35-36 Bericht, 1878.
Brünn—Naturforschende Verein: Verhandlungen, xv. Band, 2 Heft, 1876; xvi. Band, 1877.
Mecklenburg (*Neubrandenburg*)—Verein der Freunde der Naturgeschichte: Archiv, 31 Jahrg. 1877: 32 Jahrg. 1879.
Marburg—Gesellschaft zür Beförderung der gesammten Naturwissenschaften: Zitzungsberichte, 1876-77; Schriften, Band xi.; Abhandlungen 1 (Hess), 2 (Müller), 3 (Speck).
Mannheim—Verein für Naturkunde: Jahresbericht, xvi.-xix. 1870-76.
Gratz—Naturw. Verein für Steiermark: Mittheilungen. Jahrg. 1877 u. '78.
Passau—Naturhistorische Verein: xi. Berichte, 1875-77.
Offenbach-am-M.—Offenbacher Verein für Naturkunde: Berichte, 15-18, 1876-7.
Pesth—Royal Hungarian Society of Sciences: Almanach 1876-7-8; A Dunai Trachytesoport, Dr. Koch, Antal, 1877; Literarische Beuchte aus Hungarn, von Paul Hunfalvy, 1 Band, 4 Heft, 1877; Repertorium, i. 1876; Köslemenyck, xi.-xiii. Kötet, 1873-6; Ertekezesek, vi. Kötet, 7-12, 1875; 1-2, 1877; v. Kötet, 1-10; iv. Kötet, 5-8; vii. Kötet, 1-16, 1876; viii. Kötet, 1-7, 1877;—Icones Selectæ iv.: Hymenomycetum Hungariæ; Elettani Intézetenek Leirása, J. Jeno; Az Agy Tyiödése, irta Géza, 1877; Deak Terenez, irta L. Jozsef, 1876; Polymicroscop, L. Jozsef: Cranioscopea, irta L. Jozsef, 1875.
Royal Institut Géologique de Hongrie: Mittheilungen, iv. 2-3, 1878; v. 1-2; vi. 1.
Trieste—Società Adriatica di Scienze Naturali: Bollettino iii. 3, 1878; iv. 1878; v. 1-2, 1879.
Bamberg—Naturforschende Gesellschaft: I. Bericht, 2 Lief. 1877.
Königsburg—K. physikalisch-ökonomische Gesellschaft: Schriften, xvii.-xviii. Jahrg. 1876-7.
Erfurt—K. Akad. gemeinützìger Wissenschaften: Jahrbücher, neue folge, Heft viii.-ix. 1877.
Hanover—Naturhistorische Gesellschaft: 25-27 Jahresbericht, 1874-78.
Bistritz—Siebenbürgen Gewerbeschule: iv.-v. Jahresbericht, 1878-79.
Darmstadt—Verein für Erdkunde: Notizblatt, xvi. Heft, 1877; xvii. Heft, 1878.

Lüneburg—Naturw. Verein für das Fürstentum Lüneburg: Jahrschefte, vii. 1874-78.
Münster—Westfälischen Provincial-Verein für Wissenschaft u. Kunst: vi. -vii. Jahresbericht pro 1877-78.
Elberfeld—Naturwissenschaftliche Verein: Jahresberichte, 5 Heft, 1878.
Chemnitz—Naturwissenschaftliche Gesellschaft: vi. Bericht, 1877.
Heidelberg—Naturhistorische-medicinische Verein: Verhandlungen, ii. Band, 2-4 Heft, 1878-9.
Kiel (*Schleswig Holstein*)—Naturwissenschaftliche Verein: Schriften, Band iii. Heft 1, 1878.
Karlsruhe—Naturwissenschaftliche Verein: Programm der Polytechnischen Schule zu Carlsruhe, 1878-9.
Basel—Naturforchende Gesellschaft: Verhandlungen, vi. Theil, 1-4 Heft, 1875-78.
Bern—Algemeine Schweitzerische Gesellschaft die gesammten Naturwissenschaften: Verhandlungen, 1872-3; Schafhausen, 1874; Actes, à Bexpom, 1877; Lausanne, 1878.
Naturforchende Gesellschaft: Mittheilungen, Jahre 1876, No. 906-922, Bern 1877; Jahre 1877, No. 923-936, Bern 1878.
Neuchatel—Société des Sciences Naturelles: Bulletin, T. xi. 1-2 cahier, 1877-8.
Zurich—Naturforschende Gesellschaft: Vierteljahreschrift, xxi. Jahrg. 1-4 Heft; xxii. Jahrg. 1-4 Heft, 1877.
Erdgenosche Polytechnische Schule: Programm 1877-8 u. 1878-9.
St. Gallien—Naturwissenschaftliche Verein: Berichte, 1875-6 u. 1876-7.
Geneva—Institut National Genevois: Bulletin xxii. 1877.
Chur—Naturforschende Gesellschaft Graubründens: Jahresberichte, xviii. -xxi. Jahrg. 1873-4 zu 1876-7; Beitrage zür Kentniss der Umgebungen von Chur, 1874.
Lausanne—Société Vaudoise des Sciences Naturelles: Bulletin, xv. 1878; xvi. 81-82, 1879.
Bruxelles—Académie Royale des Sciences, des Lettres et des Beaux-Arts: Bulletin, T. xli.-xliv. 1876-7; Commission Royale d'Histoire—Voyages des Souverains des Pays-Bas, par M. Gachard, T. i.-ii. 4to, 1876-77; Documents Inédits, T. ii. & iv. 1877; Américaine, 1877-78 (two copies); Bulletin de la Fédération des Sociétés d'Horticulture de Belgique, 1860-76 (14 vols.)
Société Entomologique de Belgique: Comptes Rendus, No. 45-59, 1877-78; Annales, T. xx.-xxi. 1877-8.
Société Malacologiques de Belgique: Annales, T. ix. 1874, T. xi. 1876; Procès-verbaux, T. vi. 1877, T. vii. 1878; Quelques Conseils aux Chasseurs d'Insectes, par A. Prudhomme de Borre.
Société Royale de Botanique de Belgique: Bulletin, T. i.-xv. 1862-1876, 8vo.
L'Observatoire Royal de Bruxelles: Annales Météorologiques, 1874-5-6, 4to.
Liége—Société Géologique de Belgique: Annales, T. ii.-iii. 1875-6.
Louvain—L'Université Catholique de Louvain: Annuaire. 1878-9; Thèses; Soc. Littéraires, Mémoires, xii.
Bordeaux—Société des Sciences Physiques et Naturelles: Mémoires, T. 2, 1878; T. iii. 1-2, 1878-9.
Société Linnéenne: Actes, xxxi. et Atlas, 1877; xxxii. 1878; xxxiii. 1-2, 1879.
Académie Nationale des Sciences, Belles-lettres et Arts de Bordeaux: Actes, 1874-78; 36e-40e année, iii. séries. 8vo; Table Historique et méthodique (1812-75), Documents historiques et Manuscrits de l'Ancienne Académie (1712-93).
Metz—Académie Impériale de Metz: Mémoires, lvii. année 1875-6; (lviii.) 6e année, 1878.
Verein für Erdkunde zu Metz: i. Jahresbericht pro 1878, Metz, 1879.

Caen—Académie Nationale des Sciences, Artes et Belles-lettres de Caen : Mémoires, 1877, '78 et '79.
Société Linnéenne de Normandy : Bulletin, 2e série, T. 4-7, 1870-3.

Paris—Société d'Anthropologie de Paris : Bulletin, T. xii. 2-4, 1877, 3e série, T. i. 1-4, 1878 ; T. ii. 1-2, 1879.
École Polytechnique : Journal, T. i.-xxviii. (45e cahier), Paris, 4to. 1878 (complete series).

Cherbourg—Société Impériale des Sciences Naturelles : Mémoires, T. xx. 1876-7.

Nancy—Société des Sciences de Nancy : Bulletin, série 2, T. iii. fasc. 7, 1877 ; T. iv. fasc. 8-9, 1878.

Luxembourg—L'Institut Royal Grand-Ducal de Luxembourg : Publications, T. xvi. 1877.

Montpellier—Académie des Sciences et Lettres de Montpellier : Mémoires, T. ix. 1, 1876 ; Mémoires de la Section de Médicine, T. v. 1, 1872-6.

Lyons—Académie Imp. des Sciences, Belles-lettres et Arts : Mémoires, T. xxi. 1875-6 ; xxii. 1876-7, des Sciences ; T. xvii. 1876-7, des Lettres.
Société des Études Scientifiques de Lyon : Bulletin, T. iii.-iv. 1877-78 ; Règlement de la Société, 1878 ; Sur certaines relations entre les Plantes et les Insectes, par Sir John Lubbock, F.R.S., etc., traduite par Fèlix Chassagnieux, Lyon, 1878.

Auxerre—Société des Sciences historiques et naturelles de L'Yonne : Bulletin, T. xxxi. 1877 ; xxxii. année 1878.

Bologna—Accademia delle Scienze dell' Istituto di Bologna : Memorie, T. vii. 1-4 ; T. viii. 1877 ; T. ix. 1-2, 1878 ; Rendiconto. 1876-7, 1877-8.

Milan—R. Istituto Lombardo di Scienze, Lettere ed Arti : Memorie, vol. xiii. 1877 ; xiv. 1, 1878. Rendiconti. vol. ix. 1876 ; vol. x. 1877.
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Naples—Accademia delle Scienze Fisiche e Matematiche : Atti, vol. vi. 1875 ; Rendiconti, anno xii., xiii. e xiv.

Modena—R. Accademia di Scienze, Lettere ed Arti · Memorie, T. xvii 4to, 1877.

Venice—R. Istituto Veneto di Scienze, Lettere ed Arti : T. ii. 1-10. 1875-76 ; T. iii. 1-7, 1876-7.

Florence—R. Comitato Geologico d'Italia : Bollettino, vol. vii. 1876 ; vol. viii. 1-2, 1877.
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Pisa—Società Toscana di Scienze Naturale : Atti, vol. iii. 1877-8 ; vol. iv. 1, 1879 ; Processi Verbali, 1878-9, Luglio.

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CORRIGENDA.

Plate XXIII, No. 322, read, איל not אול.
Page 201, line 5, read ϫⲟⲙ. not ϫⲟⲛ.
" " " 6, " ϫⲟⲛ, " ϫⲟⲙ.
" " " 9, " Ϫ· " ϫ.
" 203, " 2, " כסא. " אסכ.
" " " 13, " צהר. " צאר.
" " " 16, " koan, " kaan.
" 205, " 10, " ⲛⲛⲃ, " ....
" 211, " 15, " baba, " aba.
" " " 22, " *Γραικοῖς*, not *Γρυκαῖς*.
" " " 26, " a. bubao, " abubao.
" 214, " 23, " Iscariot, " Isharist.
" 218, " 1, " ⲁ̀ⲛⲃ, " ⲣⲛⲃ.
" 220, " 12, " a. " as.
" 221, " 25, " ⲃⲉⲙ, " ⲃⲉⲛ.
" 228, " 17, " ⲉⲓⲟⲩ, " ⲉⲓⲱⲟⲩ.
" " " 27, " ⲧⲁⲛ, " ⲧⲁⲣ.
" 231, " 37, " *πρῶτον*, " *πρώτον*.
" 232, " 38, " *μάχαιρα*, " *μάχειρα*.
" 239, " 25, " colon, " colum.
" 242, " 12, " יצא. " יעא.
" " " 19, " *kor*, " kon.
" 249, " 24, " eun, " oun.
" 254, " 8, " revolvit, " revolivt.
" 260, " 7, put line 8 before line 7.
" 263, " 9, read ϩⲛⲣⲧ, not ϩⲛⲛⲧ.
" 264, " 31, " *μέλιτα*, " *μήλιτα*.
" 267, " 13, " ϩⲱⲛ, נב. hn. nb, ϩⲱⲛ, ⲛⲛⲃ.
" 269, " 16, " poind, not pont.
" 273, " 14, " inde a. " indea.
" 276, " 4, " שמש. " שבש.
" 279, " 35, " Fohi, " Tohi.

THE

TRANSACTIONS

OF THE

ACADEMY OF SCIENCE

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CONTENTS.

149
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CONTENTS.

ERRATA.

Page 328, formula (9), for $\frac{n^2 - 1}{1}$ read $\frac{1}{n^2 - 1}$.

" 329, 6 lines from top, for "water" read "refracting."

" 337, top line, after "fibre" insert "in the magnetometer."

" 349, upper table, for resulting dip at Lutesville read 67° 46'.7.

THE TRANSACTIONS OF THE ACADEMY OF SCIENCE OF ST. LOUIS.

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CONTENTS.